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Preservation of Coffee Baskets in the Nursery.

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NOTICE

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Vol. XVI]

[No. 1

Sugarcane Cultivation on the Irwin Canal Farm

BY

B. Narasimha Iyengar, B.A., Ph.D., *Director of Agriculture*

As a result of the new policy of irrigation decided upon for introduction in the Irwin Canal tract—a system based on a regular rotation of crops in which paddy is allowed to be grown on any piece of land only once in three years—the establishment of a large Agricultural Station to study problems peculiar to the tract, devise proper kinds of rotation, find out suitable varieties of crops, and supply the best possible seed to the cultivators became a necessity and was sanctioned by Government in the latter part of June 1931.

The site selected for the Farm is six miles from Mandya railway station on Bangalore-Mysore line, and is situated between the two main branches of the Irwin Canal and draws its water supply from the first sluice of the Cauvery branch. The site itself is situated between the villages of Ganadalu and Shivalli and is part of a subsidiary ridge nearly two miles in length from west to east and about three-fourths of a mile in width from north to south. The top of the ridge itself is almost flat and slopes gently from west to east. The side-slopes from the centre towards north as well as south are rather sharp in some places.

The site was selected after detailed soil survey work in the whole tract of over 1,20,000 acres and as far as soil conditions are concerned, it is quite representative of the area to be irrigated.

The area of the Farm itself is nearly 650 acres, about 400 acres of which were poor pasture land belonging to Government and 250 acres of private land acquired for the purpose. About one-half of the area consists of good friable red loam of an average depth of two to three feet and the other half is either stony or gravelly. Here and there in the area there do exist patches of sandy soil. Quite close to the water courses which form the boundaries on the northern and southern sides are to be found small strips of clay soil with nodules of limestone embedded in it.

As the Irwin Canal tract with its assured water supply is being developed as an area of intensive cultivation of sugarcane in the interests of the Sugar Factory established at Mandya, the operations on the Farm itself commenced with cane cultivation in July 1931.

A bit of 10 acres of Government waste land quite near the top of the ridge was got ploughed for the first time in November 1930 in anticipation of establishing the Farm. Due to want of adequate and well-distributed rainfall, the land in question had a very scanty growth of grass which used to be scraped away by the neighbouring villagers as soon as it had made a couple of inches of growth after a shower of rain. As a chief requisite for good and successful cultivation in the area was water, further operations could not be started till the irrigation authorities supplied it in June 1931.

Agricultural operations were commenced regularly from July 1931 onwards. The already once ploughed land was cross-ploughed, harrowed, cultivated and laid out into plots of about $5/12$ acre in size. As the variety of cane grown in tank-irrigated lands in the neighbourhood is a thin variety of cane called 'Cheni', seed material of an improved variety of cane, H. M. 320 was got from the Hebbal Farm near Banga-

lore. Planting was commenced on 22nd July and finished on 10th August 1931. Besides planting H. M. 320 cane on an area of 10 acres, another two acres was planted with eight other varieties of cane for comparative trials.

After the field was prepared as mentioned previously, furrows were opened at a distance of 3 feet apart from each other. A mixture of 1 cwt. of sulphate of ammonia and 1 cwt. of concentrated super per acre was applied in the furrows, irrigated and setts of cane planted immediately. The seed rate was 8,000 single setts per acre and each sett had three eyebuds generally. About 6 to 8 weeks after planting, a second dose of sulphate of ammonia was applied in the furrows at the rate of 2 cwt. per acre and immediately irrigated. About six weeks later on or three months after planting, groundnut oil cake at 10 cwt. per acre and compost manure at three tons per acre were applied in the furrows and the crop was earthed up. About 30 rows of 25 feet each in length were then connected with each other so that irrigation water could be run in a zig-zag manner round 30 rows at a time.

To begin with, the land itself had a very sparse growth of grass. The compost manure used was made by the Mysore Municipality out of street sweepings and night soil and contained one per cent nitrogen on an average. As very few weeds sprang up even later on, it may safely be said that the compost manufactured was either absolutely free from weed seeds or their vitality at least had been destroyed during the process of making it.

After the crop was earthed up at the age of three months, the only attention paid to it was with regard to irrigation and it was given once in four or five days as was found necessary.

As the object was to use the crop entirely for seed purposes, it began to be harvested from April 1932 onwards and the material obtained was planted on over 200 acres on the Farm itself. Besides, about 50,000 setts were sold to private parties for seed purposes.

It may not be uninteresting to know the yield of crop grown as above on land coming under crop for the first time.

The average yield for the whole area of 10 acres on which H. M. 320 was grown, worked out to 45 tons of cane per acre. There were 24 plots in all, and the yield from individual plots varied between 31 and 54 tons of cane per acre according to the age at which the crop was cut. The number of setts obtained per acre varied according to age of the crop, from 1,20,000 to 1,94,000. The total cost of cultivation upto the harvest including cost of seed as well as manure but excluding overhead charges, land-tax and water-rate worked out to Rs. 210 per acre.

The crop which was planted on the Farm from April 1932 onwards was cut for seed from the early part of 1933 and supplied to cultivators in the area for growing cane and supplying it to the Sugar Factory at Mandya in 1934. Besides supplying seeds for over 2,500 acres outside the Farm, material was used for planting a new area of 150 acres on the Farm itself. Out of the 200 acres harvested for seed, 180 acres were ratooned for supplying as much cane as possible to the Factory in the first season of its working in 1934. To meet the demand for seed, 54 acres out of the newly planted area had to be cut when the crop was six months old and then allowed to ratoon.

From 1932, the scheme of manuring was slightly altered. Application of oil-cake was given up, and the dose of sulphate of ammonia was raised from 3 cwts. to 5 cwts. per acre. Concentrated super was given at one cwt. per acre and compost at 3 tons per acre.

The area of 200 acres on which cane was grown for seed purposes during 1932-33 consisted of 11 plots varying in size from a couple of acres to 40 acres. There was not sufficient time between the acquisition of private land and planting of cane on it to prepare it sufficiently well for the cane crop. Moreover, certain areas got water-logged during the rains and drainage channels could not be laid out in time.

On land coming under crop for the first time and for the crop on which conditions were somewhat normal, the yield varied between 25 to 30 tons of cane per acre. On land which

was poor in quality or hurriedly cultivated for planting cane in time or which was water-logged, the yield varied between 12 and 19 tons of cane per acre. The average for the whole area of 200 acres was only 18.5 tons of cane per acre when the crop was cut at an average age of 10 months. The number of setts obtained varied between 44,000 and 1,02,000 per acre giving an average of 67,450 per acre. The cost of cultivation including charges for harvesting and cutting into setts varied between Rs. 150 and Rs. 207 per acre working out to an average of Rs. 182 per acre. As setts were sold at Rs. 4 per single 1,000, the average gross income amounted to nearly Rs. 270 per acre. As the cost of cultivation does not include overhead charges, land-tax, water-rate, etc., these have not been taken into consideration when working out the net profits per acre which amount to nearly Rs. 88.

The cane crop planted in 1933 was mostly meant to be supplied to the Sugar Factory in 1934. As already stated, the area of 330 acres consisted of plant as well as ratoon cane. To be more exact, plant cane occupied an area of less than 100 acres, and ratoon cane an area of over 220 acres. Owing to some unforeseen difficulties in the Factory, the crop could not be cut as soon as it was ripe. Consequently, it became partially pithy with the consequent loss in weight. During 1933-34 also the size of plots varied between 2 acres and 40 acres.

The best yields from ratoon cane were from those very plots which had produced a plant cane crop of 25 to 30 tons in the previous season. The yield varied between 28 and 32 tons of cane per acre giving an average of nearly 30 tons of cane per acre. It would certainly have been much more if the crop could have been harvested in time and not allowed to form pith. The yields from other plots of ratoon cane varied between 9 and 20 tons of cane per acre. The average for the whole of the ratoon area of nearly 220 acres worked out to nearly 22 tons of cane per acre. The cost of cultivation including cost of transport of cane to the Factory at Rs. 2 per ton worked out to Rs. 153 per acre on an average, the maximum being Rs. 185 and the minimum Rs. 126 per acre. The gross

average return per acre works out to Rs. 264 with the realised price of cane at Rs. 12 per ton.

The area under plant cane during the same season was less than 100 acres as already stated. This was spread over 8 plots varying in size from 2 acres to 20 acres. Owing to hurried activities to put down as large an area as possible under cane to make the Factory a success by assuring it a supply of cane for 200 working days, cultivation was rather indifferent. Besides, all available land of any quality whatever had to be brought under cane. In spite of all the disadvantages the plant cane crop was not a bad one.

The yields from the best plots varied between 27 and 38 tons of cane per acre while those from poor quality of land varied between 19 and 24 tons per acre. The average for the whole area worked out to nearly $25\frac{1}{2}$ tons of cane per acre.

The cost of cultivation including transport charges of cane to the factory worked out to an average of Rs. 249 per acre, the maximum being Rs. 280 and the minimum Rs. 222. The gross return per acre works out to Rs. 306 leaving a net profit of Rs. 57.

During the next season, the area under cane was reduced to make land available for the study of other crops.

Out of a total area of nearly 200 acres planted and ratooned during 1934, an area of 170 acres was harvested for milling purposes to the end of January 1936 and supplied to the Sugar Factory at Mandya. The remaining area was harvested mostly for seed purposes.

The total amount of cane harvested from the above area of 170 acres and supplied to the Factory amounted to 5,884 tons giving an average yield of 34.6 tons per acre. The total amount realised is over Rs. 70,500 and the cost of cultivation including the value of bullock labour employed, cost of manures, cost of seed and expenses of transport to the Factory, but excluding water-rate, land-tax and overhead charges, amounted to about Rs. 37,913. As sugarcane is the main money crop on the Farm, it seems reasonable to debit $\frac{2}{3}$ of

the establishment charges to the cultivation of cane. This amount works out to about Rs. 6,700. Adding land-tax at Rs. 1-8-0 per acre and water-rate at Rs. 15 per acre, the total cost of production of cane delivered at the Factory works out to Rs. 47,420 leaving a net income of Rs. 23,080 nearly. This works out to a net profit of Rs. 136 per acre which can be taken as the return for all capital investment on lands.

Out of the total area of 170 acres mentioned above, 97 acres had been devoted for growing plant cane. The size of individual plots varied from $11\frac{1}{2}$ acres to 36 acres and the yield per acre varied from a maximum of 52 tons to a minimum of 31 tons giving an average of nearly 45 tons. All the above plots had already grown 2 crops of cane—a plant crop harvested in 1933 for seed purposes, and a ratoon crop harvested in 1934 for being milled at the Factory. After growing a green manure crop for about 10 weeks after the harvest, early in 1934, the green crop of sunhemp was ploughed in and cane was again planted late in 1934. Manure at 1 cwt. of concentrated super phosphate, 7 cwt. of sulphate of ammonia and 3 tons of compost per acre was given to the crop. An average yield of 45 tons of cane per acre proves clearly that cane can be grown continuously without rotating it with any other crop. The cost of cultivation per acre including transport of cane to the Factory, but excluding overhead charges, land-tax, and water-rate varied between Rs. 245 and Rs. 295 per acre giving an average of Rs. 277 per acre. Since Rs. 2 per ton was paid as transport charges to the Factory, the average cost per acre for cane cut and delivered at the field itself works out to Rs. 277—Rs. 90 or Rs. 187 only. If we add to this, land-tax, water-rate and cesses at the rate of Rs 20 per acre, the cost of cane production works out to Rs. 207 per acre or Rs. $4\frac{1}{2}$ per ton.

From an enquiry into the cost of cultivation conducted at Bannur independently as required by the Imperial Council of Agricultural Research, the average cost of production of cane by the raiyats in that area has worked out to Rs. 192 per acre for a crop of 32 tons or Rs. 6 per ton of cane cut and delivered at the fields.

The remaining area of 73 acres had been devoted to ratoon cane. The size of plots varied from 11 acres to 29 acres. The yield of crop varied from 18 tons to $24\frac{1}{2}$ tons of cane per acre giving an average of 21 tons nearly. The cost of cultivation exclusive of land-tax, etc., varied from Rs. 146 to Rs. 152 per acre with an average of Rs. 149. If cost of transport to the Factory is excluded, then the cost of production of ratoon cane works out to Rs. 149—Rs. 42 or Rs. 107 nearly. If we add Rs. 20 per acre towards taxes, etc., then the cost of production works out to Rs. 127 per acre or Rs. 6 per ton. It is thus seen that in spite of savings in cost of cultivation owing to low yields it really costs more to produce one ton of cane as a ratoon crop than to produce the same as a plant crop. This point will be further investigated during 1935-36.

The Farm has just produced three crops of cane, and a fourth one is being harvested while land is being got ready for the fifth crop. Besides the above described work connected with large-scale cultivation of cane, experiments are being carried out to evolve new varieties of cane. Like all seedling canes, H. M. 320 has got the habit of arrowing in October or November if planted between January and April. If such arrowed cane is not milled within a certain time after arrowing, the cane begins to form pith in it and consequently loses weight which is rather a serious drawback from the cultivators' point of view. It may not always be possible for the Sugar Factory to permit cane to be cut at a time most advantageous to the cultivator. The aim of the Sugar Factory that has got to pay for its raw material is to get the cane at a stage when the maximum amount of sugar can be recovered from it. Cane planted between April and September seems to stand very well even when it is more than 16 months old. A large amount of work is being done by the Economic Botanist to evolve a type of cane suited for being planted in the early part of the year and which can satisfy the requirements of the cultivator and the Factory as well to a reasonable extent. Besides, a large number of varieties of cane—indigenous as well as exotic—are under trial to find out if they are in any

way superior to H.M. 320 and also to provide material for evolving new types of cane.

The problem of ratooning too offers certain difficulties. Experiments are being conducted to find out at what age the plant crop should be cut to give a satisfactory ratoon crop. Soil conditions also seem to influence a ratoon crop to a great extent. Moreover, methods of cultivation as well have to be suitably modified to suit the needs of a ratoon crop. Experiments in all these directions are being conducted.

The manurial requirements of plant as well as ratoon cane are also being experimented with. Special attention is being devoted to find out how far organic nitrogenous manures like oil-cake or a complete manure like compost can be replaced by chemicals like sulphate of ammonia without detriment to the physical condition of soils. The potash requirements are also being studied with a view to find out if such manuring is going to improve quantity or quality of crop. The potash manures for the purpose are being supplied free by the Overseas Potash Syndicate in Calcutta.

Experiments in all the above directions as well as frequency of irrigation have not yet advanced sufficiently far to be commented upon just at present.

Due to continued presence of cane throughout the year in all stages of growth, the borer pest has become rather a serious problem. Simple cultural methods as well as biological control by the introduction of parasites have helped to keep the pest under good control on the Farm itself. Details of methods followed have been described in a previous number of this journal.*

The appendix contains some information with regard to the ripening of cane (H. M. 320) planted or ratooned at different seasons. Although the data available may not be considered to be sufficient to warrant definite conclusions

* See "Sugarcane Borer Control in the Mysore State", by T. V. Subrahmanya Iyer, D.P. IN AGR., Entomologist, and C. V. Ramiah, Superintendent, Irwin Canal Farm, in Vol. XV, No. 4. of this Journal.

being drawn the following indications deserve to be noted:—

1. Cane planted during January to March ripens in 11 to 13 months while that planted later during May to September takes 14 to 16 months to mature.

2. The sugar content of canes planted during the earlier months appears to be slightly higher than that in later planted canes.

3. In respect of length of time during which the cane keeps without deteriorating after it is fully ripe, later planted canes seem to be somewhat better, than earlier planted crop.

4. The behaviour of ratoon canes is not very different from that of plant canes in regard to any of the points noted above. Canes ratooned during the earlier part of the year take less time to ripen than those ratooned later, but the latter keep on without much deterioration for slightly longer time.

Table showing comparative cost of production of cane during various years.

Year	Nature of crop	Area in acres	Yield in tons per acre			Cost of Production in Rs. per acre		
			Maximum	Minimum	Average	Maximum	Minimum	Average
1931-32 ..	Nursery cane ..	10	54	31	45	..	..	210
1932-33 ..	Seed cane ..	200	30	12	18.5	207	150	182
1933-34 ..	Plant cane ..	100	38	19	25.5	200	171	195
1933-34 ..	Ratoon cane ..	220	32	9	22.0	116	102	109
1934-35 ..	Plant cane ..	97	52	31	45.0	198	182	187
1934-35 ..	Ratoon cane ..	73	24.5	18	21.0	114	98	107

N.B.—1. Land-tax, water-rate, supervision charges have not been taken into consideration in calculating cost of production. Cost of bullock labour employed has been included.

2. Cost of transport of cane from the Farm to the Factory has also been excluded in figures for 1933-34 and 1934-35.

APPENDIX.

Influence of time of planting on the maturity of sugarcane on the Irwin Canal Farm, Mandya. H.M. 320 Plant Cane and Ratoon.

Sl. No.	Date of planting or ratooning	Date of analysis	Brix at N. T.	Glucose per cent	Sucrose per cent	Purity
1	January 1933 arrowed	8th May 1934	18.9	0.69	17.0	89.94
2	Do not arrowed	do	19.6	0.39	17.9	91.33
3	21st January 1933 ..	6th Dec. 1933	20.52	0.46	18.50	90.15
4	January 1933 ..	Dec. 1933	20.72	0.43	..	..
5	Do ..	Jan. 1934	20.24	0.37	..	..
6	February 1933 ..	Feb. 1934	20.32	0.17	19.3	94.98
7	Do ..	do	18.84	0.45	16.9	89.70
8	Do ..	March 1934	22.72	0.21	21.1	92.87
9	Do ..	May 1934	19.87	0.37	18.1	91.10
10	Do ..	June 1934	19.24	0.37	..	..
11	March planting 1933	Jany 1934	17.04	1.18	..	..
12	Do ..	do	18.24	0.90	..	..
13	Do ..	Feb. 1934	19.74	0.52	17.2	87.1
14	Do ..	do	19.64	0.50	18.2	92.7
15	Do ..	March 1934	20.72	0.37	19.5	94.1
16	Do ..	do	19.72	0.39	18.5	93.8
17	Do ..	May 1934	19.39	0.42	17.65	91.03
18	Do ..	do	18.68	0.54	16.75	90.15
19	Do ..	8th June 1934	19.05	0.37	17.40	91.34
20	February planting 1934.	17th Jany. 1935	20.78	0.41	19.0	91.43
21	Do ..	8th Feb. 1935	18.52	0.60	16.3	88.0
22	May planting, 26th May 1934	7th June 1935	16.67	1.63	14.0	83.90
23	Do ..	11th—13th July 1935	18.10	0.43	16.4	90.6
24	Do ..	14th—17th Aug. 1935	20.99	0.26	19.5	92.9
25	Do ..	11th—15th Sept. 1935	20.53	0.18	19.2	93.5
26	Do ..	8th Nov. 1935	20.39	0.17	18.8	92.2
27	June planting, 8th—9th June 1934	7th June 1935	17.27	1.54	14.7	85.1
28	Do ..	11th—13th July 1935	17.90	1.07	16.2	90.5
29	Do ..	14th—17th Aug. 1935	21.19	0.41	19.5	92.02
30	Do ..	11th—15th Sept. 1935	20.98	0.26	19.6	93.4
31	July planting, 1st—10th July 1934	7th June 1935	16.67	2.09	14.0	83.9
32	Do ..	11th—13th July 1935	17.70	0.76	15.6	88.1
33	Do ..	14th—17th Aug. 1935	20.39	0.75	18.6	91.2
34	Do ..	11th—15th Sept. 1935	20.84	0.23	19.6	94.05
35	Do ..	8th Nov. 1935	21.92	0.10	20.65	94.21
36	July planting, 6th July 1934	11th—13th July 1935	18.30	0.65	17.0	92.90
37	Do ..	14th—17th Aug. 1935	20.07	0.75	18.2	90.80
38	Do ..	11th—15th Sept. 1935	20.78	0.16	19.55	94.08
39	Do ..	8th Nov. 1935	21.79	0.14	20.55	94.30
40	July planting, 10th July 1934.	7th June 1935	15.70	2.50	12.70	80.9
41	Do ..	11th—13th July 1935	18.70	0.88	16.70	89.3
42	Do ..	14th—17th Aug. 1935	20.98	0.61	19.20	91.5
43	Do ..	11th—15th Sept. 1935	21.38	0.16	20.0	93.5
44	Do ..	8th Nov. 1935	21.19	0.17	20.0	94.4
45	July planting, 14th—29th July 1934	11th—13th July 1935	18.70	0.86	..	..

Sl. No.	Date of planting or ratooning	Date of analysis	Brix at N. T.	Glucose per cent	Sucrose per cent	Purity
46	14th—29th July 1934	14th—17th Aug. 1935	21.31	0.42	19.6	91.97
47	Do ..	11th—15th Sept. 1935	20.58	0.25	19.4	94.20
48	Do ..	9th Nov. 1935	20.98	0.20	19.8	94.40
49	August planting 15th August 1934	7th June 1935	15.78	2.27	12.6	79.85
50	Do ..	11th—13th July 1935	17.80	0.90	..	..
51	Do ..	11th—15th Aug. 1935	20.11	0.43	18.65	92.74
52	Do ..	8th Nov. 1935	21.47	0.19	20.10	93.60
53	August planting, 1st— 4th August 1934	7th June 1935	14.70	3.29	10.90	74.15
54	Do ..	11th—13th July 1935	17.70	0.88	15.80	89.20
55	Do ..	14th—17th Aug. 1935	20.78	0.52	19.35	93.10
56	Do ..	11th—15th Sept. 1935	20.11	0.59	18.90	93.98
57	August planting, 13th —31st August 1934	11th—13th July 1935	18.60	1.20	16.20	87.10
58	Do ..	14th—17th Aug. 1935	20.58	0.48	18.80	91.35
59	Do ..	11th—15th Sept. 1935	21.65	0.17	20.50	94.60
60	Do ..	9th Nov. 1935	20.85	0.15	19.65	94.23
61	August planting, 21st —28th August 1934	11th—13th June 1935	17.80	1.10	15.50	88.30
62	Do ..	14th—17th Aug. 1935	19.84	0.56	18.0	90.70
63	Do ..	11th—15th Sept. 1935	20.18	0.40	18.1	89.69
64	Do ..	9th Nov. 1935	19.92	0.26	18.5	92.90
RATOON.						
65	February ratooning, 17th—24th February 1933	Dec. 1933	19.84	0.54	..	..
66		Jan. 1934	20.11	0.36	..	..
67		Feb. 1934	22.65	0.13	20.6	90.9
68		March 1934	20.72	0.25	19.1	92.1
69	March ratooning	Dec. 1934	20.91	0.49	..	..
70		Jan. 1934	21.11	0.26	..	..
71	Do ..	Dec. 1933	20.04	0.50	..	..
72		Jan. 1934	20.65	0.32	..	..
73		Feb. 1934	21.65	0.16	20.6	95.1
74	Do ..	Dec. 1933	20.51	0.49	..	..
75	Do ..	Jan. 1934	20.25	0.28	..	..
76		Feb. 1934	20.65	0.22	19.6	94.9
77	Do ..	Dec. 1933	19.45	0.83	..	..
78		Jan. 1934	21.31	0.33	..	..
79		Feb. 1934	20.85	0.19	19.5	93.5
80		March 1934	20.92	0.31	19.9	95.1
81	Do ..	Dec. 1933	20.25	0.50	..	..
82		Jan. 1934	20.65	0.30	..	..
83		Feb. 1934	21.85	0.18	20.5	93.8
84		March 1934	18.18	0.73	16.3	89.6
85	April ratooning .. 1st—30th April 1933	Jan. 1934	20.11	0.29	..	..
86		Feb. 1934	19.44	0.23	18.6	95.6
87		March 1934	21.38	0.22	19.8	92.6
88		May 1934	18.52	0.39	16.35	82.8
89		June 1934	19.32	0.48	17.5	90.5
90	April ratooning, 1st—10th April 1933	Dec. 1933	19.85	0.74	..	..
91		Jan. 1934	19.71	0.31	..	..
92		Feb. 1934	20.64	0.14	19.5	94.4
93		March 1934	21.32	0.25	20.5	96.1
94		May 1934	18.72	0.43	16.85	90.0

Sl. No.	Date of planting or ratooning	Date of analysis	Brix at N. T.	Glucose per cent	Sucrose per cent	Purity
95	April ratooning, 11th—20th April 1933	Feb. 1934	19.04	0.26	17.2	90.3
96		March 1934	19.98	0.33	18.25	91.3
97		May 1934	18.32	0.33	16.9	92.2
98		June 1934	18.85	0.48	17.2	91.3
99	June ratooning ..	Jan. 1934	17.04	1.08	..	..
100		Feb. 1934	18.44	0.55	16.8	91.1
101		March 1934	18.91	0.61	17.2	90.9
102		May 1934	19.05	0.50	17.4	91.3
103	July ratooning 10th—16th July 1933	8th June 1934	16.83	0.96	15.0	89.1
104	July ratooning ..	do	18.85	0.86	16.85	89.4
105	Do	do	16.76	0.92	14.70	87.7
106	August to September ratooning, 5th Aug. 1933—20th Sept. 1933	do	17.50	1.09	15.4	88.0
107	February 1934 ratooning	17th Jan. 1935	21.04	0.37	19.5	92.68
108	Do	do	20.58	0.34	19.4	94.20
109	Do	do	21.04	0.30	19.9	94.60
110	June ratooning 10th—11th June 1934..	11th—13th July 1935	19.50	0.70	17.4	89.20
111	Do ..	14th—17th Aug. 1935	20.92	0.34	19.2	91.80
112	Do ..	11th—15th Sept. 1935	20.65	0.20	19.3	93.46
113	Do ..	9th Nov. 1935	20.87	0.18	19.45	93.20
114	August ratooning, 2nd—13th August 1934	11th—13th July 1935	18.50	0.90	17.0	91.90
115	Do ..	14th Aug. 1935	20.58	0.63	18.6	90.38
116	Do ..	11th—15th Sept. 1935	21.65	0.17	20.3	93.70
117	Do ..	9th Nov. 1935	21.79	0.13	20.5	94.80
118	September ratoon., 1934	11th—13th July 1935	18.70	0.86	16.70	89.30
119	Do ..	14th—17th Aug. 1935	20.71	0.56	19.0	91.70
120	Do ..	11th—15th Sept. 1935	18.92	0.35	18.4	92.40
121	Do ..	9th Nov. 1935	20.39	0.33	19.0	93.18
122	September ratoon., 12th—28th Sept. 1934.	7th June 1935	16.58	1.79	13.8	83.20
123	Do ..	11th—13th July 1935	16.90	1.20	17.0	89.90
124	Do ..	14th—17th Aug. 1935	19.38	0.63	17.4	89.90
125	Do ..	11th—15th Sept. 1935	20.45	0.25	19.0	92.90
126	Do ..	9th Nov. 1935	20.32	0.22	18.9	93.01
127	October 2nd—7th October 1934.	11th—13th July 1935	17.60	1.40	15.3	86.9
128	Do ..	14th—17th Aug. 1935	20.58	0.69	18.8	91.3
129	Do ..	11th—15th Sept. 1935	20.31	0.43	18.6	91.6

Suggestions to maintain Purity of Improved Cotton Seeds

BY

S. H. Bennur, L.Ag., *Assistant Director of Agriculture*

Cotton in Mysore is grown in three distinct tracts with three distinct varieties :—

I. In the northern part of the State, mainly, in Chitaldrug district and in some taluks of Shimoga district, the variety Sannahatti corresponding to Kumta (*G. Herbaceum*) with traces of black seeded variety is grown.

II. In Arsikere and other red-soil areas and under Vanivilasasagara, the upland type — Doddahatty or Dharwar American commercially called Banavar Doddahatty, Cambodia and Anekonda varieties of cotton are grown.

III. In the Southern part of the State, bordering Coimbatore district, the perennial cotton called Nadam is grown on black cotton soil, which variety in the Madras Presidency is actually grown on poor red soil.

The Cotton Specialist of the Mysore Agricultural Department has evolved three different types of improved strains for these different tracts, *viz.*, Selection 69, M.A. II and Nadam-like respectively.

Now the next step for the demonstration section is how to keep these strains pure and unmixed with the seed of the local cotton of each tract for future sowings. Large quantities of pure seeds are required to meet the demands of these new strains, as they have already been appreciated by the ryots of these different tracts. For instance, Selection 69 cotton is already grown on about 20,000 acres in Chitaldrug district; but the produce which comes into the market cannot be guaranteed as pure, since it gets mixed with the local Sannahatti by the middlemen that purchase the stuff in retail from village to village and the mixture cotton is ginned, the seeds

of which are again distributed by the gin owners for seed purposes. So, the area under the mixture crop is on the increase year by year. Besides, this will spoil the strains, over the evolution of which a great deal of time and money has been spent and the whole thing would be an actual waste, if proper precautions are not taken in time to keep the strains pure. Unless some organisation can guarantee purity, it will be difficult for the Department to certify the stuff as pure, for further extension of the area and secure premium which the pure strains can easily fetch.

To overcome these difficulties we must start seed farms.

(1) Pure seeds from the Government Experimental Farm should be supplied to members of Co-operative Societies or Village Panchayats, who should be actual cultivators. These members should guarantee to grow only the improved strains and market the produce pure through their Society or Panchayat as the case may be.

(2) The cotton growing area should be controlled by introducing the Cotton Transport Act to have the whole Sannahatti tract growing only the improved strain, Selection 69 or any other improved strain which may be introduced later on.

(3) The Co-operative Society or Village Panchayat should purchase all such pure cotton grown from each individual member and send the whole stuff for ginning under the supervision of the Department to have the seed stocked separately for future sowings and also get better price for the superior lint. Such lint either can be sold by public auction giving previous intimation to the prospective buyers or may be sold outright to private merchants to get the benefit of the premium obtained for it, while the Department should purchase the seeds, which they know to be pure and fit for further multiplication.

If the rate for lint is not favourable at the time of auction, they might wait for a better price, meanwhile, the needy members getting 60% of approximate value of the produce

as advance from the Society. The Central Bank should finance the Village Societies at a reasonable rate of interest for such a laudable work to enable the members to reap the full benefit of joint sale of a good commodity.

A small beginning has already been made on the above lines with success from the Co-operative Credit Societies of Maradihally, Medikerenaikankote of Hiriyr taluk and Doddasiddavanahally Co-operative Society of Chitaldrug taluk in this connection.

It is hoped that other Co-operative Societies in the cotton tracts mentioned above will follow the good example of the above Societies and open the way for a large joint central organisation, so that in course of time Mysore State may also have regular annual auction sale of improved cotton as in Bombay Presidency, though on a smaller scale. Obstructions are sure to come from the local dealers at the outset, but they may be won over, provided both the Agricultural and Co-operative Departments take the lead for the first few years till the thing gets established.

In case, the above is not possible, for want of sufficient unity among members, etc., seed farms should be started on a number of private-farms of important cotton growers. These seed farms should be registered by the Department and the owners should agree to carry on certain rules which ensure the purity of their produce. Their seed should be renewed and kept to standard by the importation of a certain quantity of fresh-selected seed from the Government Farm each year.

The produce of these farms should be inspected and if up to the required standard a seed farm certificate should be issued by the Agricultural Department to the owner; and such farms should be widely advertised giving details of the full addresses of the owners of such farms, area grown and locality, etc., in the *Government Gazette* and in the local vernacular papers well ahead of the sowing time of the particular seed. Those that wish to sow pure improved strains of cotton, may go to these seed farms and obtain seed supply of pure strain from them.

Thus, when the produce grown from seeds of such farms is brought for sale, the stuff will be considered as pure and the buyers will purchase the same giving full premium, which profits the growers; and also the purity of seeds is maintained thereby properly.

Preservation of Coffee Baskets in the Nursery

By

K. H. Srinivasan, M.A., B.Sc. (Edin.), *Senior Assistant Director*

In coffee planting two important methods of raising coffee seedlings are generally recognised, *viz.*, (1) Bed plants and (2) Basket plants. The object with which baskets are employed for this purpose is, in the main, to ensure the safety of the seedling at the planting time. If the baskets are not preserved intact, they yield to the weight of the ball of earth contained in them, or, the ball of earth sustaining the coffee seedling is liable to be broken down when handled for want of a binding agent which more often than not jeopardises the life of the young seedling. The use of baskets for raising coffee seedlings involves great expenses and unless some precautions are adopted to see that the baskets serve well the purpose for which they are intended, such a costly method of raising seedlings becomes a questionable one. Experiments were conducted on the Coffee Experiment Station to find out how best to secure good preservation of baskets in the nursery, and as the results prove to be of a great practical interest and usefulness to planters, the following details of experiments and the results obtained are furnished.

The Baskets.—Coffee baskets are made of either bamboos or bamboo reeds known as *wotte* (ವಾಟಿ). In reed baskets, the splicing used is usually very thick and hence they are stronger and last better than bamboo baskets even without any special treatment. The supply of reed baskets is limited to areas where it is abundantly available and generally got

made on the estate itself. However, the majority of estates depend entirely on the supply of bamboo baskets only. The splicing used in these baskets being usually thin, they are easily subjected to wet-rot under the conditions obtaining in the coffee nursery. Saprophytic fungii and moulds aided by abundant moisture initiate rotting and disintegration of the basket tissue. Copper sulphate is toxic to the growth of moulds and other fungii, and therefore, steeping of basket in a hot solution of copper sulphate is adopted to prevent their access into the basket tissues and thus prevent wet-rot.

Treatment of the baskets.—Experiments were conducted on the Coffee Experiment Station in three successive years from 1932 to 1934 to study this method and also to determine the economical strength of copper sulphate to be used with advantage. The details of experiment and the results obtained for the years 1932 and 1933 are furnished in an accompanying statement. The results of 1934 confirmed the previous ones in a general way; but as there was slight error in recording the observations, this series is omitted in the statement. Sets of baskets were treated in a hot and a cold solution of copper sulphate varying in concentration from 2 per cent. to 10 per cent.; and even cold bordeaux with 1 per cent. and $\frac{1}{2}$ per cent. strength has been tried. Baskets that are boiled in a solution of copper sulphate show a marked keeping quality as compared with those that are simply immersed in the cold solution of equal concentration for the same length of time. Sets treated with cold bordeaux mixture gave negative results and were found to be no better than control sets.

Test set of baskets had remained in the nursery for 212 days in 1932 and 130 days during 1933; after which they were removed for observation. Plate I shows the condition of treated and untreated baskets at the end of the test period. The results of observations are recorded in the statement as (1) very good, (2) fair, and (3) bad. The first group comprises of baskets that were found quite sound without even a trace of damage or signs of disintegration. Baskets that were just as good as those in the first group but showed symptoms

of disintegration were classed in the second group. In this category, generally, the bottom portion showed signs of rotting. The third lot consisted of baskets that were found in a wholly or partly disintegrated condition. In the untreated sets all the baskets had got completely rotted and so were the sets treated with a cold solution with the exception of those treated with a CuSO_4 concentration of 4 per cent. and above. Although the test is conducted using only a small number of baskets in each series, yet, the results are considered very satisfactory in as much as the 'bulk of baskets' treated with a hot 2 per cent. solution of copper sulphate have confirmed the results of experiments in a general way.

The experiments demonstrate the fact that *boiling* the baskets in at least 2% copper sulphate solution is essential to confer upon them immunity from the inroads of destructive moulds which cause decay and hasten rotting. Treating the baskets in the above manner has enhanced their lasting quality. It is also seen that a cold solution to be effective requires a very high concentration of copper sulphate in the solution. By having recourse to boiling, the quantity of copper sulphate needed for the purpose can be economised to a great extent. In the boiling process, it would appear, that the solution penetrates deeper and hence its importance is emphasised. Well-treated baskets are known to survive in the soil without disintegration for a couple of months as can be seen from Plate II. The coffee seedling in Plate II was recovered from the soil after 5 months and parts of the basket splicing are still seen adhering. If the baskets are well preserved, it is often necessary to cut open the bottom or the side of baskets before planting in the soil to avoid 'root binding'.

As regards the concentration of copper sulphate solution to be used higher strengths have, no doubt, stood better than others, but the question of cost is one that has to be rightly reckoned. For all practical purposes, a 2 per cent. solution seems adequate if only longer time is allowed for the boiling process; and with a five minutes duration this concentration not only gives satisfactory results but also is 50 per cent.

cheap as compared to 4 per cent. However, if the baskets are intended to stand over in the nursery for over 7 months and in localities subjected to a very heavy rainfall, it is advisable to use 4—5 per cent. solution.

Method of treatment.—The process of treating the baskets and the precautions to be adopted in the process are briefly indicated herein. For steeping the baskets one large vessel with a wide mouth is required. Tin or iron vessels should on no account be used, as these get eaten into by the chemical action of copper sulphate and hence copper vessel alone should be used. In estates where thousands of baskets are to be treated, it is economical in the long run to use a large vessel specially made for the purpose. A cylindrical copper vessel of the size of $3\frac{1}{2}$ feet in height by $3\frac{1}{2}$ feet wide will admit a whole bundle of about 125 baskets measuring 7 inches and 4 inches to be immersed in solution at a time. Using a vessel of this size 5 to 6 thousand baskets can be treated in a working day.

The boiling of baskets is best carried out near the nursery site where water is readily available. The vessel is filled with a measured quantity of water but not too full up to the brim. A kerosene tin may be taken for measuring out water. A tin of this description holds 4 gallons or approximately 41 lbs. of water. For every 10 gallons, *i.e.*, for $2\frac{1}{2}$ tinfulls of water 2 lbs. of powdered copper sulphate is added. Twenty gallons of water are at least necessary to completely immerse the entire bundle of 125 baskets. The solution should be heated *to the boiling* point before immersing the baskets and these should remain there at least five minutes before another lot is dumped in. Care should be taken to see that the baskets are fully covered with the solution, *i.e.*, completely immersed. When these are taken out, they should be rested at the edge of the vessel for the excess solution to trickle down into the vessel. When the level of the solution goes low in the vessel additional quantity of copper sulphate and water may be added from time to time to maintain the correct concentration of the solution. As already pointed out, copper sulphate is acid in

its reaction and therefore, the solution or the crystals of copper sulphate should not be thrown about anywhere in a nursery site or close to coffee or shade trees. In fact, it should not be thrown out on any piece of ground where it is intended to raise a crop, as nothing will grow satisfactorily on that particular spot unless adequately limed.

As regards the cost of treating the baskets in the above manner, no correct data is available, as the number of baskets treated annually on the Station is very small. However, it is reckoned that a man and a woman cooly should be able to handle at least 4 to 5 thousand baskets in a working day using a large vessel and that 4 to 5 lbs. of copper sulphate should be quite adequate to treat 1,000 baskets. It is therefore seen that the cost of treating 1,000 baskets works out to Re. 1-4-0 to Re. 1-8-0 approximately.

Conclusion.—From the foregoing it is obvious that treating coffee baskets in a hot solution of copper sulphate is very effective in preserving the baskets for a long time. Treating them in a cold solution has been found to be quite useless or uneconomical. A 2 per cent. solution is deemed sufficient to keep the baskets in tact for about six months and a higher concentration may be necessary where baskets are to remain for a much longer period and under conditions of heavy rainfall.

A little reflection on the advantage of steeping baskets in the manner suggested should convince planters on the desirability of adopting this method in spite of this little extra cost. At present, steeping coffee baskets in a copper sulphate solution is not in general practice. Taking the whole coffee area in the State, the loss involved by the destruction of baskets and consequent failures or loss of coffee seedlings is very great. Of late, it is indeed gratifying to state that planters visiting the Station have evinced a keen interest in this method and as a result many enquiries are received soliciting information on the subject. This article is, therefore, written in detail with the hope of not only furnishing the information required but also to create greater interest in the method of preserving baskets in the nursery.

*Results of Experiments on the preservation of Coffee Baskets,
in the Nursery.*

					1932	1933
(1)	Date of treating baskets	..	..	..	26-2-32	24-3-33
(2)	Boiled for	..	..	..	2-3 minutes	2-3 minutes
(3)	Baskets arranged on	..	..	..	2-3-32	28-3-33
(4)	Date of examination	..	..	..	1-10-32	5-8-33
(5)	Total number of days in bed	..	..	..	212	130

Description of treatment	No. of baskets treated	Condition of baskets on 1-10-32			No. of baskets treated	Condition of baskets on 5-8-33		
		Very good	Fair	Bad		Very good	Fair	Bad
Control sett ..	26	..	..	26	24	..	..	24
10% copper sulphate solution Boiled ..	25	24	1	..	..	..	..	..
5% Do ..	26	24	2	..	..	..	..	..
2% Do ..	28	26	2	..	24	15	5	4
4% Do ..	..	..	..	..	24	22	2	..
3% Do ..	..	..	..	..	24	..	24	..
10% CuSO ₄ Cold ..	23	16	7	..	..	..	..	..
5% Do do ..	27	4	23	..	..	..	..	..
2% Do do ..	26	..	2	..	24	..	..	24
4% Do do ..	..	..	..	..	24	..	24	..
3% Do do ..	..	..	..	..	24	..	..	24

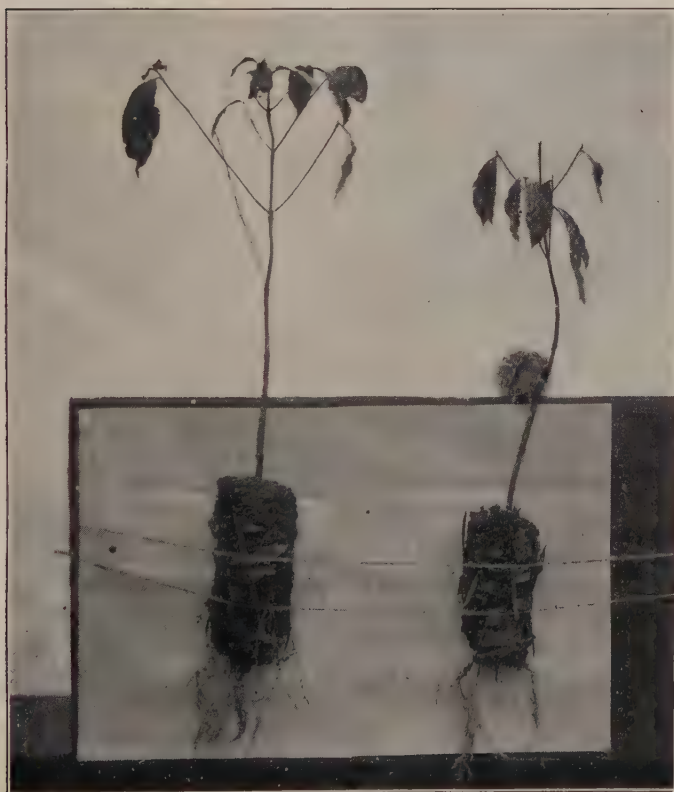
**Proceedings of the Seventeenth Annual Field Day
and General Meeting held on 28th March, 1936**

The Annual Field Day of the Union for 1936 was held on the Government Experimental Farm, Hebbal, on Saturday, the 28th March, 1936.

Members arrived at the Farm at about 8-30 in the morning and the first item on the programme was to go round the Cattle Show and Exhibition that had been specially arranged for the occasion. The interest and enthusiasm evinced by some of the prominent ryots of Hebbal and other villages in the vicinity of the Farm were mainly responsible for the success of the Show and the Exhibition. Among the animals exhibited were very good specimens of bullocks, cows, buffaloes, goats and sheep, most of them the progeny of sires kept on the Farm for the benefit of the cattle of the surrounding



Middle six baskets treated with 4% hot CuSO_4 solution compared with 2 checks on either side.



Coffee seedlings recovered from soil after 5 months showing remnants of baskets.



Goats—prize winners on the Field Day.



Improved method of rearing chickens.

villages. Poultry exhibits included some good turkeys, peahens and leghorn and country fowls. There was a demonstration of modern methods of rearing of chickens. Improved methods of bee-keeping and extraction of honey were among the items in which the visitors evinced considerable interest. Jaggery boiling was also demonstrated. Select exhibits from the several Scientific Sections of the Department and agricultural produce from the Farm and the surrounding villages arranged in the School rooms formed the bulk of the Exhibition. More than 400 persons including members of the Union, students of the Agricultural School and other guests that had come for the Field Day and ryots from the surrounding villages passed through the Exhibition stalls.

The party then went round the fields. Although sugarcane was the only crop left for inspection the number and varieties of experiments in progress provided enough of material for members and other visitors interested in the improvement of this—one of the principal money crops of Mysore.

After dinner the members gathered for the business meeting at 3 o'clock in the afternoon. This meeting went on till 4-30. The proceedings are reported in the following pages. At 5 o'clock in the evening there was a general assembly with K. V. Anantaraman, Esq., B.A., Revenue Commissioner in Mysore, in the chair for distribution of prizes to the exhibitors.

After a hearty vote of thanks to the Chairman, the pleasant function terminated with three cheers to His Highness the Maharaja.

LIST OF PRIZE WINNERS.

Gourds	..	Prize Commended	Mr. Munisami, Guttahalli. White Gourd, Hebbal Farm.
Carrots	}	.. Prize	Mr. Gangappa (Turnips).
Turnips		.. Commended	Mr. B. Achanna.
Beet root			
Knolkhol	..	} Commended	Mr. Aiyappa.
Chowchow	..		
Cabbage	..		
Tomatoes	..	Prize Commended	Mr. Muniappanna, Manarayanpalya. Mr. Annayappa, Yerrannapalya, Hebbal Farm.

LIST OF PRIZE WINNERS—(Contd.)

Composite collection of 13 vegetables	Prize	Mr. Muniappa of Cholanayakanahalli.
Fruits (Plaintains)	Prize Commended	Mr. Ramasastry, S/o Krishnasastry, Hebbal. Mr. Munisamappa, Guttahalli.
Sugarcane	Prize	Mr. L. Ramayya of Gantenahally for best H.M. 329
Jaggery	Prize Commended	Mr. K. T. Narayanagowda. Hebbal Farm.
Poultry	Prize Commended	Sir H. C. Dinshaw (Leghorn). Mr. Syed Hussain, Bhupsandra.
	Commended	Mr. Parakasi of Nagenanalli (Peahens).
Draft Bullocks	Prize Commended	Mr. Munisamappa, Munireddipalya. Mr. Thimmarayappa, Thindlu.
Breeding Bulls	Prize Commended	Mr. Thimmarayappa, Thindlu. Sir H. C. Dinshaw for Sindhi bull.
Milking Buffalo	Prize	Sir H. C. Dinshaw for Delhi buffalo.
Milking Cow & Calf	Prize	Mr. Muniyappa of Cholanayakanahalli.
Sheep	Prize	Mr. Syed Hussain, Bhupsandra.
Goats	Prize	Mr. Jacob, Mariyammanapalya.
Rams	Prize	Mr. Munisamappa, Cholanayakanahalli.
Implements	Commended	Seed drill, Hebbal Farm.

The Union acknowledges with thanks the help rendered by the Principal, the Vice-Principal, staff and students of the Mysore Agricultural School, Hebbal, and the Manager and staff of the Hebbal Farm in connection with the Field Day and the ryots of the surrounding villages who co-operated with the Union staff in all the arrangements they had to make for the Field Day.

Business Meeting

The business meeting commenced at 3 p.m. with Dr. B. Narasimha Iyengar, Director of Agriculture and President of the Union, in the chair. At the outset the attendance of members at General Meetings came up for discussion and it was pointed out by Mr. M. S. Ramachandra Rao that of late fewer members were found attending the meeting than before, necessitating frequent adjournments. The number of members attending the adjourned meetings, he added, was

generally fewer than at the original meetings. He therefore suggested that the meeting should carry on the business on the agenda waiving the bye-law about the quorum. This was agreed to by the rest of the members. Consequently the following resolution was moved by Mr. M. S. Ramachandra Rao and supported by Mr. G. Venkataramaniah and Mr. Patel Hanume Gowda.

“ Resolved that the quorum for conducting business at General Meeting be fixed at twenty (20) ”.

The resolution was passed unanimously.

Next Mr. M. S. Ramachandra Rao proposed the following resolution appreciating the services of Mr. N. Venkatsubbaya who was till recently the Secretary of the Union.

“ This meeting places on record its deep sense of appreciation of the services of Mr. N. Venkatsubbaya who served the Union for over 15 years.”

This was seconded by Mr. G. Venkataramaniah and carried unanimously.

The Secretary then presented the annual report with statement of accounts of the Union for 1935. After a few general observations on some of the points referred to in the report Mr. M. S. Ramachandra Rao proposed its adoption. Mr. Hongenhalli Sreenivasa Rao and Mr. G. Venkataramaniah supported the proposition. The report was unanimously adopted.

The President then explained to the members that while being thankful for the help accorded by the Government, the Union should be able to show more work in response. It is necessary in the first instance to appeal to the Village Panchayats and increase the number of subscribers to the Kannada Journal. Members should try to conduct more experiments and report upon them in greater detail. Further, the President pointed out a new and additional line of work for the members by proposing a scheme of seed distribution. He informed the members that the Department of Agriculture have thought of a method of seed distribution through ‘A’

farms and 'B' farms. Under class 'A' would fall those farms which received pure seed from the Central Government farms and after growing the crops pure and without mixtures themselves, were in a position to supply guaranteed seed for further expansion. A field or two on the farms of each of the Union members, he said, may be sown with the pure seeds to be supplied by the Department and could be easily worked as 'A' farms. To be definite and practical he said that members in particular districts may take up just those crops evolved for and needed by those particular districts: for example, cotton seed could be increased in the Chitaldrug district, Nat-ragi in Kolar district and paddy in the canal area.

Dr. V. K. Badami supported and explained further the scheme of seed expansion proposed by the Director. He said that good seeds do spread among the farmers in a way; for example 900 pallas of H. 22 ragi have been raised round Hebbal Farm and other places this year, G. E. B. 24 paddy has spread all over Mysore and H.M. 320 variety of cane is almost a local variety now. Still the spread of the new and improved strains of seeds should be greatly organised and their purity continuously kept up. The Department of Agriculture would give in advance certain quantities of seeds to those members who agreed to start 'A' farms and help them to keep their plots pure. As purchase of these seeds for cash might not work in several instances, seeds would be given on condition that the growers should return to the Department a year after, *i.e.*, after harvest, the same quantity of the guaranteed seed as they took before. This seed would be supplied to other farmers for multiplication and thus, generally speaking, going round from the central farms to the 'A' farms, from the 'A' farms to the 'B' farms and from there to the generality of the cultivator, each good strain would in the course of 5 years distribute itself all over the State to the extent required.

Dr. V. K. Badami explained that the new work was not proposed in place of the old experimental work which should continue, but that it ought to be possible to easily comprehend and take up the new piece of work at once as it could get on



Oxen—prize winners on the Field Day.



Cow and Calf—prize winners.



Local Cattle—prize winners.



Improved breeds—Delhi buffalo, Sindhi bull and cow & cross-breed cow and calf.

even with less care and trouble and arrangement than the former one.

The following members agreed to take up 'A' farm work.

- | | |
|--|-----------------------|
| 1. Mr. M. S. Ramachandra Rao. | Ragi and Paddy. |
| 2. „ Hanume Gowda, Marulenhalli. | Ragi. |
| 3. „ K. T. Narayanagowda, Kalludi. | Nat Ragi and Tobacco. |
| 4. „ K. Chowdiah, Minakanakurki. | Nat Ragi. |
| 5. „ Lakshman Gowdah, Subbanhalli. | Sugarcane and Ragi. |
| 6. „ Hongenhalli Sreenivasa Rao. | Sugarcane. |
| 7. Major C. B. Oakley, Kadakola. | Kar Ragi. |
| 8. Sir H. C. Dinshaw, Anchepur Estate. | Hain Ragi. |

Action taken by the Managing Committee in connection with the appointment of the new Secretary was then explained to the members. Mr. B. Venkatanaranappa moved the following proposition.

“The Secretary of the Union shall be an officer of the Agricultural Department deputed for this work by the Director of Agriculture.”

Mr. G. Venkataramaniah supported the resolution. It was carried. It was suggested by Mr. B. Venkatanaranappa and agreed to by the rest of the members that the officer so deputed be not on that score a member of the Managing Committee.

Proposed by Mr. M. S. Ramachandra Rao : “That the word “Secretary” be deleted in the bye-law from the list of office-bearers to be elected.”

Mr. G. Venkataramaniah seconded the proposal. The members agreed to the necessary changes in the bye-law.

After this the elections commenced. Dr. Badami pointed out that it has been usual to propose the Director of Agriculture to the Presidentship of the Union. Mr. B. Venkatanaranappa proposed that “Dr. B. Narasimha Iyengar be elected President for the coming year.” The proposition was seconded by Mr. Hongenhalli Sreenivasa Rao and carried unanimously with acclamations.

Dr. V. K. Badami proposed that the Union should have the benefit of the Vice-Presidentship of Mr. B. Venkatanaranappa for the coming year also and Mr. G. Venkataramaniah supported the proposal. It was carried unanimously.

Then the following 12 members were elected for the Committee for the coming year from among 15 candidates.

1. Mr. S. Lakshman Reddi.
2. „ M. S. Ramachandra Rao.
3. „ G. Venkataramaniah.
4. Dr. V. K. Badami.
5. Mr. H. Sreenivasa Rao.
6. „ T. S. Raghavachar.
7. „ A. K. Yegnanarayana Iyer.
8. „ M. J. Narasimhan.
9. „ Hanume Gowda of Marulenhalli.
10. „ Shankar Rao Badami.
11. Srimati D. Sakamma.
12. Major C. B. Oakley.

The meeting closed with a vote of thanks to the retiring members and the Chairman of the evening.

M. VASUDEVAMURTHY,
Secretary.

Annual Report for 1935

By

The Secretary

It is my privilege this afternoon to submit this the Seventeenth Annual Report of the Mysore Agricultural and Experimental Union for the year 1935.

For the first half of the year under report Mr. N. Venkatsubbaya was the Secretary of the Union and I succeeded him in September, 1935.

EXPERIMENTAL WORK DURING 1935.

At the very outset I am constrained to observe that during the year under report only 9 members out of 125 undertook to conduct experiments. Seventeen experiments were arranged to be conducted, 6 with sugarcane, 5 with paddy, 3 with groundnut, 2 with ragi and one with cotton. Three members have sent results of 7 experiments conducted by them while 7 experiments are reported to have failed. The vagaries of seasonal conditions and low prices of farm produce prevailing since a number of years have of course been responsible for

the small number of experiments undertaken. But our members will appreciate the view that the experiments themselves *inter alia* have the purpose of improving the profits from agriculture and it is hoped more members will come forward to take up the experiments in the coming year.

Experiments on sugarcane conducted at Sabbanahalli, Goribidnur Taluk, during the year under report indicated that H. M. 320 and H. M. 544 striped (preference being given to the former) are better suited to this locality than H. M. 607 whose yields were low and which flowered completely.

Paddy varieties S. 246 and G.E.B. 24 were tested against Alur sanna and Halubbalu at Lakshmanasandra near Tumkur, and Sabbanahalli, Manchenahalli and Kalludi in the Goribidnur Taluk and in each case their performances were decidedly of a superior order, G.E.B. 24 being better than S. 246.

To Sabbanahalli again we owe the returns of experiments on Ragi and Groundnut. Results with the latter crop were non-indicative whereas H. 45 and H. 55 ragis gave a crop yield of 30 per cent. grain and 20 per cent. straw more than H. 22 with which they were compared.

JOURNALS.

The Kannada monthly Journal is being published regularly and the 4th Number of Vol. 12 has just been issued. I am glad to say that the English Journal is also making up for lost time and with the publication in June of the 2nd Number of Vol. XVI the Journal will have been brought up-to-date. I may however again submit that contributors to this Journal are still lacking and I appeal to all interested in the progress of Mysore Agriculture to let us have their views for publication.

FINANCE.

Our income is made up firstly of Government subvention and secondly of entrance fees, membership fees and subscriptions to the Journals. The subvention has ever been our mainstay. The Government have sanctioned the grant till the end of June 1937, with the proviso that the Union should greatly increase its subscriptions. The number of our members and

subscribers is now 236, which is a small one. This, I beg to submit, should increase at least to 1,500 to enable the Union to finance itself without external aid.

I may mention in this connection that Government were pleased to order as early as 1933 that 25 to 30 Village Panchayats in each taluk should be selected for subscribing to the Kannada Journal. It is however a sad fact that to-day there are only 65 Village Panchayats on our books against a total of 11,000 in the whole State. It is to be fervently hoped that with the continued and sympathetic co-operation of the officers of the Revenue Department this number will be added to in hundreds if not in thousands during the coming year.

The following is the statement of Income and Expenditure commencing from 29-2-1935 to the end of 20th March, 1936 :—

RECEIPTS			EXPENDITURE		
	RS.	A. P.		RS.	A. P.
Opening Balance ..	2,345	9 3	Establishment ..	1,766	2 8
Admission Fee ..	30	0 0	Press bills paid ..	2,295	9 0
Membership Fee ..	372	0 0	Postage ..	127	8 0
Subscriptions ..	517	6 0	Annual Meeting and Field ..		
Subvention for 1935-36 ..	2,500	0 0	Day, 1935 ..	230	6 7
Miscellaneous ..	26	12 8	Miscellaneous (Contingencies) ..	25	14 1
			Total ..	4,445	8 4
			Cash on hand ..	1,346	3 7
Grand Total ..	5,791	11 11	Grand Total ..	5,791	11 11

Estimated receipts and expenditure upto the end of June 1936.

RECEIPTS			EXPENDITURE		
	RS.	A. P.		RS.	A. P.
Cash on hand ..	1,346	3 7	Establishment for 4 months ..	544	0 0
Estimated income from ..			Press bills pending payment ..	258	0 0
English Journal ..	250	0 0	Estimated cost of printing 3 ..		
			numbers of Kannada Journal ..	210	0 0
			Estimated cost of printing 2 ..		
			numbers of English Journal ..	300	0 0
			Contingencies and Postage ..	125	0 0
			Annual Meeting and Field Day ..		
			for 1936 ..	300	0 0
Total ..	1,596	3 7	Total ..	1,737	0 0

M. VASUDEVAMURTHY,

Secretary.

SELECTIONS

Corn from the Sheaves of Science

The amount of feed needed by a hen in one year is : for a Cantonese, 30 kgm.; a white Leghorn, 33.9 kgm.; a Nagoya, 34.0 kgm.; a Mikawa, 36.0.; a Rhode Island Red, 40.0 kgm.

To produce one dozen eggs, a hen requires the following weight of feeds : a Cantonese, 2.1 kgm.; a white Leghorn, 2.2 kgm.; a Nagoya, 2.3 kgm.; a Mikawa, 2.3 kgm.; a Rhode Island Red, 2.5 kgm.

Sunning the eggs prior to placing them in the incubator and every three days thereafter will result in a significant increase in percentage of hatchability.

—*The Philippine Agriculturist*, Vol. XXIII, No. 10.

Saving and Spending

Addressing a group of co-operative students recently on the subject of saving and spending, Professor Hall observed, "Two or three years ago there was a great controversy in the press as to whether it was wise for people to save or whether it would be better to spend. Many believed in spending; but I hope to-day we shall form our own opinion." Then he went on to say that money lent to a co-operative society, building society or manufacturer was spent on capital goods, *viz.*, buildings, machinery, etc., which created consumable goods that the people required. In a sensible community they would just save enough and spend enough and have just enough machinery to produce the quantity of goods that the people's incomes would buy. If people save too much money it meant they were spending less on consumable goods, with the result there was a bigger supply on the markets, prices fell, production was cut down, and there was more unemployment.

—*The Madras Journal of Co-operation*, Vol. XXVII, No. 2.

The Mineral Requirements of Milking Cows

The following table gives some idea of the enormous amount of mineral elements moved from the soil by grazing. The milk of twenty cows yielding 1,000 gallons each annually, contains the equivalent of approximately :—

1,120 lb. Nitrogen.

380 lb. Phosphoric acid = 1,999 lb. superphosphate.

340 lb. Potash = 1,700 lb. Potash Fertilisers.

2,000 lb. Lime.

Of a cow's entire weight, $4\frac{1}{2}$ per. cent. consists of mineral matter. A newly-born calf weighing 80 lb. contains approximately $3\frac{1}{4}$ lb. of

vital minerals, all of which came from its dam. An ordinary cow produces 800 gallons of milk per annum, and this contains 50 lb. of mineral matter, which is more than is found in the entire frame of a 1,200 lb. bullock that has taken three or four years to grow, yet the dairy cow produces this yearly in addition to what goes to make her calf, as before mentioned. Each ten gallons of normal milk contains three-fourths of a lb. of the most valuable form of bone building mineral matter—which makes it so valuable for children and young animals generally. During heavy milk production it is impossible for the cow to get sufficient mineral matter from untreated pastures. Thus, if the animal is not fed a large amount of rich mineral concentrates, she is compelled to draw on her body reserves, calling first upon that in the bone, and then upon the minerals in the blood. In the first instance this leads to a spongy, weak bone, and if this continues long the animal soon becomes unthrifty and a prey to various forms of disease due to a lowered resistance capacity. Disease is the extreme effect of mineral deficiency, and it is probable that there are degrees of deficiency, which cause a serious decrease of production as far as dairying is concerned. — *Extract from the Agricultural Gazette, New South Wales, June 1935 in the Journal of the Jamia Agricultural Society, Vol. XXXIX, Nos. 11 and 12.*

Food Value of Groundnut Cake

Gandhiji invites special attention to the following note on the food value of the groundnut cake by Prof. D. L. Sahasrabuddhi.

There is a good deal of preaching done to encourage the use of soya beans as a food material, while groundnut which is extensively grown in India is not given the consideration it deserves. Groundnut is a very valuable oil-seed and food material. Groundnut itself is not easy for digestion and many times causes digestive disturbances. This is, however, due to the presence of a very high proportion of oil—50 per cent. If the oil is extracted from well-cleaned seed, the oil-cake left behind is a highly nutritious food material for human consumption and does not cause any trouble. The following is the average analysis of groundnut cake and soya beans.

	Groundnut cake per cent.	Soya beans per cent.
Moisture	8	8
Proteids	49	43
Carbohydrates	24	19.5
Fat	10	20.0
Fibre	4	5.0
Mineral matter	5	4.5

The groundnut cake compares very favourably with the soya beans. It is actually better than soya beans in the essential constituents, namely, the proteids and the mineral matter. Further, the groundnut proteid is better than soya bean proteid in essential amino-acids as shown by the following figures :—

Essential Amino acids				Groundnut proteids per cent.	Soya bean proteids per cent.
Tyrodine	..	..	..	5.5	1.86
Agrinine	..	..	..	13.5	5.12
Histidine	..	..	..	1.88	1.39
Lysine	..	..	..	5.50	2.71
Eystine	..	..	..	0.85	—

If at all any biliousness is caused by groundnut cake, use of a small quantity of jagger or a little soda-bi-carb will be a good preventive.

The groundnut cake has a very good taste and its keeping quality can be improved by heating and keeping the cake in a properly closed vessel.

Sweets and ordinary articles of food can be prepared from groundnut cake. Attempts must, therefore, be made to spread the knowledge about the usefulness of groundnut cake. It is certainly equal to and even better than soya beans.

—*Sunday Times.*

Food, Farmer and Future

“Food, Farmer and Future” is the subject of an article by Professor Henry F. Armstrong, F.R.S., in *Nature*, Vol. 136, No. 3441 of Saturday, October 12, 1935. It sets out to define an agricultural policy for the future, the trend of which is already felt to be an obvious desire to introduce scientific practice into our affairs.

The attitude of the article towards education is summarised in the concluding sentence, “Education at the present day is worthless for all practical purposes; its fulcrum, in future, must be the belly through favour of the farmer.”

Referring to the means of Agriculture briefly a warning is struck that people will perish not from lack of knowledge but from lack of organic matter. “Agriculture has two great problems to consider that of water supply and that of waste disposal. We cannot afford to waste organic matter. We must have humus manures if we are to put quality into agricultural produce, especially into table vegetables. All town waste must be collected and specially treated.”

The food problem is introduced with the remark that ‘Life is so complex that we have forgotten how entirely food is its foundation and mainstay’. Milk, bread and sugar are discussed in some detail.

"Everything has yet to be learnt about milk. Certain deficiencies are to be recognised even in the best product whether these are innate or the consequence of long continued malnutrition, due to exhaustion of soils, is a question. In fact we do not yet know what milk is, might be or should be Like ourselves when properly fed cattle will be free from disease." Then follow the suggestions that cultivation of grass and other feeding stuffs should be properly understood that with the suitability of different districts for different cultivations local standards of excellence may be set up, that it must be possible by supply in other seasons of fodder grown and cut in particular periods of the year, to equalise any seasonal shortcomings in the quality of milk, and that with reference to the milk products it must be practicable even to call upon the dairy maids to show "that they have the imagination to produce distinctive articles."

As regards bread, the case is made out for the whole-wheat one as against the white-flour one. "We need to go back to the local mill and the local baker."

About sugar the article has the following say, thereby giving an example also of how scientific details and human affairs go together.

"May be we shall soon be led to discourage the consumption of sugar and reduce its use to a minimum. Evidence is accumulating that it is an undesirable, if not a bad food, except when used to meet the strain of extreme muscular exertion as in racing or climbing. The rise in the consumption of sugar, in modern times, is remarkable especially in the United States; coincidentally there has been a marked fall in the amount of bread eaten. Americans are directing attention to a surprising change in national type to the growth of obesity and even flabbiness in character. Are we not also losing character and becoming sugary in outlook? Sugar definitely spares fat—women are right in avoiding it, on this account. Worst of all, we starve ourselves in eating sugar in any quantity: it carries nothing with it—no mineral matter, nothing that is body building. On this account it is bad for children. Finally, it is probable that resistance of infectious disease is lowered by an excess of sugar in the blood."

M. V.

Milch Goats

A word in regard to the value of goat's milk. The T. B. Bacillus has not yet been found in goat's milk. This fact is one of great importance, more so as this dread disease is on the increase in India. Further the digestibility of goat's milk is much greater than that of cow's milk or buffalo's milk. Its value for dyspeptics is shown by the fact that in New York, Chicago, and other large cities in the U.S.A., goat's milk

retails for twice the price of the best cow's milk, being in much demand for hospitals and sanatoriums.

Coming now to a comparison of goat's milk with cow's milk, certain interesting facts stand out at once. Indians do not, we believe, like goat's milk. Why, perhaps, because of its odour and taste. This is entirely a matter of management. We have produced goat's milk absolutely without odour and when offered to friends to drink, could not be distinguished from cow's milk. The peculiar taste often associated with goat's milk is probably due to the goats having been fed on Nim leaves, which are extremely bitter, and also to the presence of the male with the milking herd. In many ways goat's milk is certainly superior to cow's milk. An important difference between the cow's milk and goat's milk is this. Goat's milk is alkaline, cow's milk acid in reaction; a difference which may mean life and death to any one with a very weak stomach. Further cow's milk requires two hours for digestion, goat's milk 30 minutes; a saving of $\frac{3}{4}$ of the work for the stomach; another life and death difference in many cases of weak digestive organs. If one studies the mineral-salt contents of three milks, *i.e.*, cow, goat and human, it is interesting to note that there are twelve different mineral salts found in the three kinds of milk, but not all of them in any one milk. All but three of the twelve are to be found in goat's milk, only six in cow's milk, and but five in human milk; a difference of no mean importance. Further cow's milk is almost without iron, whereas goat's milk has from 7 to 10 times as much of that very important element in the blood of all warm-blooded creatures. High medical authorities have said that "if cow's milk contained a little more iron it would be the 100 per cent. perfect food." It is also well known that the phosphates are bone-forming elements; of 7 phosphate salts the milk of the cow carries 0.508 parts, the milk of the goat which is a much smaller animal, 0.319; and human milk the disproportionately small total of 0.096. When we come to the salt containing potassium, we find the order reversed, and the small goat showing 0.483 parts to the cow 0.282; a truly remarkable thing, when we consult Webster and find him telling us that "Potassium has the most powerful affinity for oxygen of any known substance, and takes it from every other compound". Add to this the iron content in goat's milk, and we have an oxygen-absorbing power in goat's milk uncomparable with any other milk.

Thus has Chemistry clearly shown us, why the "poor man's cow," is so strong and vigorous, and so readily adaptable to all climates, and why her milk is so super-superior as a food, and also a therapeutic agent, both of which are being continually demonstrated in many thousands of cases all over the world.

It is these factors that make goat's milk an ideal feed for infants and children. In India this is of the utmost importance. (Extract from the *Allahabad Farmer*, July 1935).

—*The Journal of the Jamaica Agricultural Society*, Vol. XXXIX, No. 10.

Vegetable Oils as Lubricants

BY

Prof. Georges Ray

One of the characteristics of the present age, in all spheres of human activity, is the predominance of the machine and the increasingly general employment of motor power, the tendency of which is to supplant completely the muscular effort of the human being and of work animals, or in any case to render this work less trying and more effective.

On the farms, progress in mechanisation and in use of motor power is so evident that it is difficult not to ascribe to this factor an important share in responsibility for the onset and persistence of the crisis.

Whatever types of motors are employed or machines utilised for cultivation, for the transport of products of the oil or for their industrial transformation, the first and the fundamental problem to be solved is that of lubrication. Every mechanical installation includes metal parts which must be ensured against the least possible wear and tear from friction. This makes desirable the choice of appropriate lubricants, and necessitates careful attention to the improvement of lubrication and the investigation of new lubricating media.

There is too general a tendency to regard these problems as solved. A wide publicity, extraordinarily well-organised by the large companies dealing with transport and the treatment of petrol, has directed public attention towards the mineral oils and greases. Preferences tend to follow sentiment rather than scientific criteria, and in this sphere of activity the Americans have imposed their publicity methods by reiterated and imperative statements, intended to catch and forcibly retain the attention of the reader.

In view of the necessity for finding new trade channels for agricultural products and of the steps that are being taken to narrow down cost prices and generally to reduce farming expenses, the efforts of farming circles may well be directed towards investigations of a practical kind, with the object of substituting, either wholly or partially, mineral oils by vegetable oils, in connection with the lubrication of internal combustion engines, of the different parts of other engines and of all kinds of farm machines.

At present there is no very great choice in this respect, and the only oils of vegetable origin which can be used as lubricants are olive oil and castor oil.

The use of castor oil for the lubrication of gas engines is essential in aviation and in fact in a number of countries the Army Commissariat is directed to purchase castor oil seeds for the purpose.

The qualities of olive oil, as machinery oil, have long been known in the navy, but the producers have taken less interest in the question in consequence of certain somewhat trifling complications in the conditions of contract for the supplies.

The employment of olive oil for oiling internal combustion engines and in particular for the engines of motor-cars, is much more recent. Although the question is of immense importance for cultivation, the attempts made up to the present have been only partial in character.

All that has been done is to substitute in the oiling of some few motor car engines, olive oil for mineral oil, then to travel a fair number of miles, and then to examine the condition of the pistons, cylinders and valves. The results have been satisfactory, and have been published, but the obvious conclusion has not been drawn.

It is evident that the question of lubrication of the engines of motor cars by olive oil should be taken up as a whole on scientific lines, so as to define the best conditions of utilisation and the characteristics, chemical and physical, to be required in the oils.

In the second place, consideration must be given to the popularisation of the investigations and to the testing on a large scale with appropriate publicity. Motor cars with exclusive olive oil lubrication must be entered for the races and the competitions that are so dear to the heart of the public. When Prof. Ferraguti, last year, desired to prove the possibility of substituting petrol by poor gas for driving the engines of cars, he placed his charcoal gas generator on a racing car entered for the famous thousand mile race and he accomplished the run to the admiration of all.

Then comes what may be called the plan of commercialisation : the establishment of marks for lubricating olive oils on sale everywhere in cans ; publicity by the ordinary methods, eulogising the excellence and effectiveness of olive oils, their advantageous price and the uniform quality of the brands offered to the public.

If the group interested will put this programme into action without allowing themselves to be distracted by considerations foreign to the object in view, the practical results will undoubtedly have a satisfactory effect on the material position of olive growers. Not only may this method of utilisation of olive oil be the salvation of a cultivation which at present lies under a severe menace, but another consideration may be

that the effects of the measures advised on the trade balance of the countries importing petrol would not be altogether negligible.

—*International Review of Agriculture*, Year XXV, No. 3.

Origin of Cultivated Plants

BY

Dr. P. S. Hudson, B.Sc., Ph.D. (Cantab.), *Imperial Bureau of Plant Genetics, Cambridge*

The subject I am going to talk to you about this evening is based on a translation from the Russian Bulletin on the origin of cultivated plants, as seen through the eyes of the Soviet Union. This subject I regard as one of the most interesting experiments in plant breeding, giving entirely a new footing to current ideas. In the old days, in improving cultivated plants geneticists were dealing with material, which attained a limit of improvement rapidly and which therefore did not provide scope for further improvements. Their going to near and related wild species to improve cultivated crops frequently led to disappointment and failure. Prof. Vavilov of Russia propounded an entirely new view of the origin of cultivated plants which opened out methods to the breeder for the improvement of his crops. His principle is not altogether new or unknown to botanists. In Ceylon, Willis, a worker of international fame on plant distribution, has covered very much the same ground. Prof. Vavilov started collecting material from all over the world with the object of saying in what parts and where richest material for breeding work could be found. His evidence tended to show that varieties distribute themselves in a definite and regular zonation. He found certain places where the wealth of plant material was richest in concentration; for example, in Afghanistan, wheats of all possible types were found, including even new species unknown to science. Moreover the new species were all found to be concentrated in a limited area near the foot of the hills, mountainous regions being an intensively rich source of new material. He also found that in passing outward from the centre of concentration, wealth of forms and types gradually reducing and falling off towards the peripheral area, where only one, two or three types were present while the inner centre contained more than a thousand different types. Another interesting observation was that the centres were characterised by other factors, *viz.*, predominance of dominant factors usually associated with primitive wild types which as one reached the periphery reduced itself, giving place to the recessive ones. He also found that these centres have no relation to regions where related wild species are found. For example, wheat which was so rich in Afghanistan was not found anywhere else, the nearest spot where it

was found being Mesopotamia. It was thus proved that the earlier geneticists were entirely wrong in dealing with those wild types which were certainly not the ancestors of the crops they had to improve.

Carrying on the observations to other plants it soon became evident that a similar state of affairs to what we found in the case of wheat existed with all plants; and from further study it emerged that there was no definite and independent centre for each individual crop, but there were some limited centres for groups of plants. According to Prof. Vavilov there are five such centres in the world as follows:—

1. South-Western Asia—Parts of Afghanistan, Mesopotamia.
2. South-Eastern Asia—The East Indian Archipelago.
3. The Mediterranean region.
4. North-East Africa—Abyssinia.
5. Central and Southern America.

The above five are the sources of the world's cultivated plants, and these plants as we now know them have originated from these centres and diffused naturally or through artificial agencies and filled the world. It is obvious therefore that if we want new farms to improve our crops these are the places to search for them.

The reason why cultivated plants should have this origin is still open to speculation. Prof. Vavilov emphasised that these regions were also the centres of ancient civilisation and agricultural population in the past. The two are somehow correlated. Whether these spots became rich in plant material on account of the population or whether the richness of the material induced colonisation, it is difficult to say. Yet another interesting feature is that these zones, excepting perhaps the Mediterranean, are mountainous, tropical and sub-tropical regions. Probably these mountains and the prevailing climatic conditions were favourable to plant variation, and mutations were more frequent. Chromosome irregularities characteristic of the peculiarities of climate probably got connected.

While therefore, the actual process of origin of these plants is a question of conjecture, it is interesting to observe the stages of domestication. In some plants this is very easy to follow. The potato, for example, exists in a large number of different forms in South and Central America. The potato of Europe and Asia show very little variation. But in South America the species exists not only in greater forms, but also in specimens of different chromosome numbers and with highly desirable qualities which the potato breeder is after. In one fertile area it is possible to find all stages of domestication of this plant. On the hill sides we find the wild type without tubers at all; then we have the type with tiny tubers which are not however of any economic

importance; then we have others with tubers of some size which enterprising people collect and use for planting near their houses, and then we come to the types which are more advanced and finally to those which are the result of selection. It is possible to trace through all the stages from the wild to the cultivated.

In many plants it is also possible to trace quite frequently and realise how the plant has developed itself in independent zones. So we cannot speak of one phase of origin. Local cultivation of the different innumerable types must have resulted in a series of cultivated groups entirely independent, sometimes related, in other different, depending on cultivation practices.

In the case of certain plants no wild forms can be traced even if we search the whole world over. This applies to ancient crops like the cultivated cereals and we are forced to conclude that no wild species ever existed. In other words, the plant arose into cultivation by two distantly related wild species crossing with each other and bringing about a new species, probably with chromosome doubling and the disappearance of the sterile characters. In substantiation of the above theory it can be stated that many ancient crops, wheat for example, exist in a number of different forms with different chromosome numbers. The variety known as the soft wheat cultivated in Central Asia and Turkestan has 42 chromosomes, while that grown in Afghanistan has only 28 and is apparently unrelated. We are forced to conclude that these originated independently with different parental species. In cotton, we find a similar thing. The American cotton found in South America is different from the Asiatic one in Afghanistan and owes its origin to different ancestors.

These several observations of Prof. Vavilov must therefore be a lesson to plant breeders who may have to entirely revise their scheme of work as a result of these observations. This leads us to the undertaking of the creation of new forms of plant life. If, in the course of centuries, Nature has been able to give us these forms, in the twentieth century, the question arises, what, understanding this working of Nature, we may not be able to do, to produce probably new and hitherto unknown cereals, fruits, vegetables, etc.

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Agriculture in Burma

BY

K. Ramiah, M.Sc., Dip. Agri. (Cantab.), L.Ag.

Paddy Specialist, Agriculture College, Coimbatore

Rice and Agriculture.—The title I have chosen, sounds ambitious, but, actually a talk on Burman agriculture will essentially be a talk on

rice cultivation in Burma ; because, rice is the most important and wealth-producing crop of the province. This can be gauged from the fact that the total value of rice and rice products exported annually from Burma, is to the tune of 30 to 40 crores of rupees, while the total value of exports of other products in which Burma is rich, namely, minerals, timber and oil, all put together amount to only 20 crores. In fact, the whole population in Burma is directly or indirectly dependent on rice.

The Agricultural Zones.—Agriculturally, Burma can be divided into three zones: A wet zone in the north, a dry tract in the middle, and another wet zone in the south. The northern zone is a hilly tract, most of the areas being unfit and still unexplored for cultivation. A number of mountain ranges start from this part of the country, the most important being Arakham, the Shan and the Pegu ranges. The total rainfall in this zone amounts to about 80 inches annually. The middle zone is dry and crops are raised here only with artificial irrigation. Most crops, including rice, are grown only in this area, which receives only about 20 to 30 inches of rainfall. Lower Burma, the third and the most important zone, receives the full benefit of the south-west monsoon with about 100 inches of rain, while a narrow strip of the country between the coast and the mountain ranges, both on the west and eastern ends of this zone, receives even as much as 200 inches. In addition to these three, there is the Shan States, a big plateau of 3 to 5 thousand feet above sea level, practically undeveloped. It is stated that it may prove a valuable tract for sheep farming.

The Importance of Rice.—As mentioned already, rice is the most important crop, occupying 75 per cent. of the cultivated area, or about 13 million acres, of which nearly 11½ million acres are in Lower Burma, about a million being in the middle zone. The only difference between these two zones is that in Lower Burma, rice is cultivated entirely as a rainfed crop, while in the dry middle zone it is grown with artificial irrigation as in Madras. The immensity of rice cultivation in Lower Burma is prominently brought to one's notice, as one travels through this tract. One sees on all sides the vast stretches of paddy fields, with green-luxuriant crop and with trees almost absent in the landscape except on the borders of creeks. The only relieving feature is the short palm, *Nipa frutescens*, which looks like a big fern, with leaves like those of the cocoanut. These leaves are used for roofing houses and occasionally toddy also is tapped from this palm.

The History of Rice Cultivation.—Until the middle of the 19th century, Burma rice was not known outside that country, the production being just sufficient to meet the internal consumption. The Lower Burma was all a swamp and undeveloped. There were no settlers and no roads, and rice cultivation was only done in patches here and there,

like the hill cultivation in Malabar and Agency tracts. After the British occupation, however (about the year 1870-1880), development took rapid strides. Government opened up roads, put up embankments and bunds to prevent flood water getting in, and dug channels to drain off water, and serve as water ways. Thus, land, which was previously subject to floods and was precarious for rice cultivation, now became eminently suitable for the rice crop. Settlers from North Burma moved over, as also emigrants from Madras, to occupy the reclaimed swamps on which lands were given on favourable leases.

The Madras emigrants were chiefly *Nattukotai Chetties*, who financed the cultivators and it is the enterprise of these *Chettians* that has been responsible, in no small measure, for the development of the Burma rice industry. The venture of these people was something like a speculation in financing a new and promising business, and although it has been alleged that in their financial dealings they have not been overscrupulous in their methods, it must be remembered that these people, far away from their homes, were taking a great risk. It is now estimated that the total amount invested by these *Chetties* in Lower Burma amounts to nearly 60 crores of rupees.

The Cultivation.—The cultivation of the crop starts with the south-west monsoon. The soils of Lower Burma are like those of our deltas, only they contain more silt than clay, as different from Madras soils which contain a bigger fraction of clay than silt. The cultivation details are not very different from those obtaining here, but one interesting thing is that the lands are ploughed only once, after which two implements unknown to us, one the Burmese Harrow, and the other the Burmese Settoon—which has a number of blades that cut weeds and curdle the soil—are passed a number of times. Considering that with a single pair, a tenant is able to finish 2 acres a day with these implements, they are worthy of trial in our country, as their adoption would result in considerable saving of expenses towards preliminary cultivation; and there is room to think, that these implements may be effective on our soils also to provide the required tilth, because, the soils of the dry middle zone, unlike those of Lower Burma, are clayey like those of our deltas, and even in this zone, these implements are in vogue.

There is practically no manuring given to the crop, although recently the Agricultural Department have been experimenting with fertilisers and have found Ammonium Phosphate 20 : 20 to give increased yields; this, however, has not been found to be paying enough in the present depressed state of the rice market.

The harvest is peculiar in that the whole plant is not cut, but only the earhead with about a foot of the straw. Actually, the plants grow very tall, $5\frac{1}{2}$ to 6 feet, and sometimes even 7 feet, and the straw is stiff

and coarse; after harvest, the straw is either left in the field and grazed by cattle, or sometimes burnt away; sometimes, it is also cut off and used for roofing houses in towns and villages.

Holdings.—The main difference between Madras and Burma is the size of the holdings; in our deltas, it is probably less than 4 to 5 acres, but in Lower Burma it is somewhere between 22 to 25 acres, and in Upper Burma 10 to 15 acres. A tenant usually manages 25 acres, with a single pair, hiring out an extra pair for the season only and the animals are after all small-sized, just like our small *Kangayams*. This, of course, is due to the thinner population with less pressure on the land unlike our deltas, and thus the bigger size of the holding is a definite factor that goes towards decreasing the cost of production of rice in Burma.

Land Tenure, Etc.—More than 50 per cent. of the holdings are managed by tenant cultivators. In recent times, a new phase has come over the old state of things. The old Burmese settlers have gradually become more and more indebted to the *Chettiars* who have been financing them and, with no prospect of the loans being returned, the land has gradually passed over into the hands of absentee landlords. This can be seen from the fact that while, in the earlier years, only 6 per cent. of the holdings was owned by *Chettiars*, in 1935, it is estimated, that nearly 22 per cent. of the area in Lower Burma is owned by them. This state of affairs has been mainly brought about by the Burmese trait, which is a national characteristic almost, namely, a pleasure-loving disposition with never a tendency to save or to repay loans. In spite of his big holdings, the Burmese ryot is always involved in debt.

Rice Varieties.—There are three classes of varieties agriculturally—the early, the medium and the late; the last two of 5½ to 7 months' duration are the most important and comprise about 70 per cent. of the total. There is no variety less than 4½ months in duration.

Out of a total production of 7 million tons, nearly 3½ million tons are exported as milled rice, and thus, trade requisites have resulted in a number of classifications amongst the rices exported from the country.

There is an impression here that Burma rice is not good; this is hardly the case. What actually happens is, that Burma rice is sent to two markets, the eastern and western. In the former, in which is included South India, the chief consideration is cheapness and in the latter, those of European countries, the criterion is quality. Thus, price outside decides quality, and, therefore, South India which imports only the cheap rice gets the poorer quality. There are several fine varieties of rice and it will not pay to import them into Madras.

The Agricultural Department and Rice.—In Madras, our chief aim is the increase of yield; in Burma, however, while reasonable yield is desired, the attention of the Department is directed more towards the evolution of strains with better milling qualities. The milling industry has thus a large voice in directing the policy of the Agricultural Department. There is always a close co-operation between the Department and the millers and no variety or strain is passed out by the Department which has not been approved by the millers.

Seed farms run by the Department are more highly developed than in India. A large amount of *poromboke* unassessed lands, classed as grazing areas which are leased out to tenants on definite conditions, have been handed over to the Agricultural Department for use as seed farms, and agricultural officers corresponding to our demonstrators, are put in charge of these areas. Each demonstrator has about 10 to 12 seed farms under him. There are two kinds of seed farms; the major seed farms are those at the headquarters of the demonstrators, and provided with threshing floor and storing facilities. The minor seed farms are with the tenants themselves with a supervision by the demonstrator. In 1935, there were 23 major farms with a total area of 2,800 acres and 153 minor farms with an area of 9,000 acres, the total produce distributed as seed being nearly 8 thousand tons of paddy. The Agricultural Department works in close co-operation with the millers and often acts as the buying agent of the mills.

Milling and Trade.—Milling in Burma is different from our conception of what it is in our country, their mills being very much bigger, some with a turn-over of even 200 tons of rice per day.

The trade is mostly in the hands of Europeans, and is a highly organised industry with headquarters in England and with a large amount of English capital. These English companies are mostly in charge of the big mills and, creating a demand in the United Kingdom, carry on a flourishing trade. The trade with India and Ceylon is not done by these companies but by Gujaratis from Bombay; these are neither cultivators nor millers, but only brokers; they get telegraphic communications of market fluctuations and buy and sell rice. Moghul Street, Rangoon, where the rice brokers all reside, strongly reminds one of the Wall Street of New York or the Stock Exchange of London in a smaller degree.

The trade is keenly alive to tastes and demands. Twenty years ago, only white rice was being exported; now, since there is a demand for parboiled rice in South India, it is being prepared and exported. The millers, who are doing business on a large scale, are out to improve the processes of preparing parboiled rice and are keenly alive to the problems arising in it. Whenever necessary, they engage chemists

specially to attack special problems. In the preparation of whole rice for the Western markets, some of the finer kinds give only about 25 to 30 per cent. head grain, the rest being classed into different grades of broken rice. This broken rice, a by-product, is usually sent to South India where there is ready sale. There is a complaint that they have lost some of this trade since the coming in of Siam in the picture.

Other Crops.—The other crops grown, besides rice, in order of area and importance, are beans, gingelly, groundnut, sorghum, maize, chillies, rubber and sugarcane. Most of these are grown in the dry middle zone, and also on a narrow strip of tract on either side of the Irrawaddy, the latter known as the riverine corresponding to our *Padugai*, cultivation on river banks.

Conclusion.—The rice cultivator in Burma has a number of advantages; he spends comparatively less on preliminary cultivation, his implements are more efficient than the plough; he uses no manure; the Irrawaddy brings him plenty of silt; his yields compare well with ours, about 1700–2000 lbs.; his assessment is low, only about 3 to 5 rupees; his holdings are large; and his mode of transport is cheap and efficient.

1. The grazing problem is not serious; the villages are scattered, the cattle are few and there is enough straw left on the fields after harvest.

2. Green manuring is not done and, in fact, when tried, was a failure; this is because, no rains are received at all during summer, when cracks develop in the soil, making it unfit for crop growth; the soil again gets soaked only with the receipt of rains in May.

3. If not the *settoon*, at least the Burmese Harrow could be used with advantage on our soils.

4. The size of fields varied from 20 cents to 5 acres depending on distance from channels.

5. The labour population, not only for agricultural but for other purposes, is mostly supplied by emigrants from Vizagapatam, who regularly sail over to Burma in batches, during the season; this is because the Burmese labour is poor.

6. The cost of production of rice per acre, which 3 years ago was about Rs. 15, ranges from Rs. 20 to Rs. 22.

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Potato Growing in Victoria*

NO. 6. PREPARATIONS FOR PLANTING.

BY

J. T. Ramsay, *Potato Expert*

In outlining the cultural operations by which land intended for a potato crop may be prepared, it is impossible to lay down any hard and fast rule which would suit all sorts and conditions of soil. This is so because there is such great variation in the soil, which may be of sand, clay, or any of the many gradations between these two extremes.

Again, varying climatic conditions demand varying treatment, and the times at which different classes of soils can be treated most advantageously will differ in the several districts. Notwithstanding all these variations, the object to be aimed at in preparing land for a potato crop, or any other crop demanding intense culture, is the correct mechanical condition of the soil or, in other words, the correct tilth.

Many landowners, possessed of country which is naturally very fertile, do not seem to appreciate the necessity of producing this condition of soil for the reception of seed. They appear to think that since they are planting seed in rich land, little more is necessary. Soil may be rich, and yet be in such a poor physical or mechanical condition as to render it entirely unsuitable for the free development of plants of high economic value.

The production of genial conditions for the reception of the seed of the potato crop is secured by the utilization of such implements as will reduce the soil to a condition of tilth which will make it amenable to the needs of the crop. There are several good reasons why this particular mechanical condition of the soil is essential. First, such a condition allows the roots of plants to branch out without restriction in search of food; secondly, useful bacterial activity is encouraged; and thirdly, percolation of water is promoted and evaporation of moisture retarded.

Wherever the depth of the soil will permit, the first ploughing should be to a depth of 7 to 9 inches, and the second about 2 inches shallower. There are many cases where the top soil is so shallow that this depth is out of the question. On land where the surface soil does not extend below from 5 to 6 inches, care should be taken not to plough to a greater depth than surface soil.

In addition to the mould-board plough, the disc or spring-tooth cultivators, the roller, and the harrows, all play an important part in

* Previous articles of this series have dealt with the conditions and selection of seed, seed storage methods, and change of seed, plant food requirements and the use of artificial fertilisers.

the production of a good seed-bed. After the second ploughing, the disc or spring-tooth cultivator should be used to further break down the soil. It is possible that only one or two strokes of the cultivator will be required to produce the desired effect. However, it is always well to err on the side of over-cultivation rather than under-cultivation.

It is not necessary or advisable to work the soil down too finely as in the event of heavy rain falling, it is liable to run together and become so closely set as to necessitate the whole of the ploughing and cultivating being gone over again.

Under normal conditions, however, if two ploughings and two disc or spring-tooth cultivations are given, the land may be allowed to lie in that condition until the time of planting. In the event of the rain falling in any quantity subsequent to these operations, opportunity should be taken, as soon as the ground is in fit condition, to carry horses or tractor, to run over it again with one or other of the cultivators. Harrowing at this stage is not necessary, and should be left until just before planting commences.

It is important, at this season of the year, to go over seed stocks in order to prepare them against the approaching planting times. Seed in boxes will require very little attention, as seed so stored keeps in the best of condition. But, it is just as well to look over these lots and remove any tubers which have dried off as the result of injury received at digging time from the fork or machine, and also any showing signs of spindly growth or decay from disease.

This saves carting useless tubers on to the paddock, where they are liable further to spread the cause or causes of their decay. In cases where seed has been stored in bags or pits, attention and overhaul are more necessary than where the seed has been stored in standard boxes. This is a very important routine operation. Every effort should be made to prevent tubers from over-sprouting, with a consequent weakening of the seed and an increasing liability of damage to the sprouts. To prevent this over-sprouting, pits should be opened up and their contents turned over.

While this is being done, opportunity should be taken to remove all tubers which are showing any sign of decay whatever. There are sure to be some which have been pitted in a damaged condition, and a varying percentage of tubers in which bacterial rot has made headway since they were placed in this storage.

After sorting over and eliminating disease-affected tubers, it is advisable that the contents of the pits be spread out at a depth of not more than about 4 inches, preferably under trees. If this be done, any tender white shoots that are showing will be hardened off by the action of the light. The same agency will green and toughen them. By this

means, they will be rendered fit to withstand the handling incidental to planting without sustaining much damage. Another beneficial effect of opening up the contents of the pits and spreading them out is that excessive growth of the sprouts will be checked.

It is important that the original sprouts on the tubers be kept intact so far as possible. If these be damaged or broken off the seed is considerably weakened and its value much reduced. Even though the shoots be broken off, in the majority of cases they will grow again, but the subsequent growths will be very much less vigorous than that from the original bud.

Where seed has been stored in bags, excessive sprouting can be prevented by turning the bags upside down at first, and reversing the standing position of the bags about every week or ten days. While this periodic inversion of the bags will tend to check the growth of the sprouts, there will be considerable damage done to the young sprouts, many of which will suffer bruising or breaking. Because of this, it would be much better if seed which has been stored in bags were subjected to the same treatment as that already recommended for seed potatoes which have been stored in pits, that is, they should be opened right up, overhauled, and spread out to the light and air until such time as they are required for planting.

It would be difficult to estimate the annual loss to the potato-growers of Australia through faulty storage of seed, but it must run into thousands of tons in the aggregate. The greater part of this loss could be obviated by the use of the proper seed potato-boxes. These storage-boxes, or trays, are now standardized here, and are so well known as to make their description unnecessary. Since I first introduced them into Victoria a large number of the growers in the more important potato-growing districts of Victoria have adopted them for use, and they have become increasingly popular. It is safe to predict that before many years the growers of consequence who do not practise this well proved and highly economical system of potato seed storage will be the exception rather than the rule.

Dipping of seed is a most advisable operation which can be attended to any time prior to planting. During the past few years the fungus disease *Rhizoctonia* or Collar Stem rot has made considerable headway and caused enormous damage to potato-crops. While this disease is prevalent, fortunately, it is one of the simplest and easiest to control. The control consists of dipping all potatoes intended for seed in a solution made from formalin and water. This may be done at any time during the storage period between harvesting and planting. The proportion recommended is 1 lb. of formalin to 20 gallons of water, and the period of immersion should be $1\frac{1}{2}$ hours. This strength is advised

for unsprouted potatoes; for sprouted tubers the strength of the solution should be reduced to 1 lb. formalin to 30 gallons of water, the time of immersion being the same. Corrosive sublimate (mercuric chloride) also is a most effective dip, but being highly poisonous its use is not generally advocated. The solution of mercuric chloride is odourless, colourless, and practically tasteless—hence its danger. The formalin treatment is quite effective in *Rhizoctonia* control, and can be practised without danger. It is also inexpensive and easy to use. In one recent test the dipping of seed resulted in an increase in yield of no less than 3 tons 10 cwt. per acre over the untreated seed. Dipping is strongly advised in all cases.

POTATO PRODUCTION UNDER IRRIGATION.

With the development of irrigation within the State there has been a gradual increase in the variety of crops treated by this method. Irrigationists in increasing numbers, for some years past, have been devoting attention to the production of potatoes, and many have obtained very successful results. On account of the amount of labour involved in the work of irrigating and cultivation, the growth of large individual areas is not advisable, as this entails the retention of large staff of men and horses to cope with the work which recurs at rush periods during the growing season. These rush periods are sandwiched between times of comparative idleness, which, of course, materially increases the cost of production.

In continuing the procedure for growing a crop of potatoes under irrigation, it is impossible to lay down any set of rules which would ensure the maximum crop in every season and every variation of soil. For instance, it might be necessary in some seasons, owing to the dryness of the soil at the date of planting, to irrigate prior to planting, while, on the other hand, the soil might contain sufficient moisture from natural rainfall to obviate the application of water from the channels. Again, some soils have greater power of retention of water than others, and therefore, require less irrigation water to produce the same result. Then again the climatic variation of the seasons might necessitate four or five irrigations (as in a dry year) or none (as in an abnormally wet year). These illustrations will be sufficient to prove that no rule-of-thumb method can be advised. The first fact to be grasped is that the potato is a moisture-loving plant, and from the time of planting the crop to the time when it is just past the full bloom, the soil should be kept as near as possible in a moist condition without being excessively wet. Certainly, at times of irrigation excessive wetness must obtain, but intelligent irrigation and the immensely rapid evaporation common to all districts where irrigation is practised, will reduce the actual time of excessive wetness to a harmless period.

THE TIME OF PLANTING.

Planting should be done as early as possible, the optimum time, of course, varying with the district. On the Werribee settlement, planting in the average season can be commenced with safety at the end of July, but in northern parts of the State the average date for safe planting is as late as from the beginning of September.

The factor governing the date of planting is the incidence of spring frosts. The later these are liable to occur, the later planting must be delayed. Supposing, in the average year, spring frosts in a district are not likely to occur later than the beginning of September then planting may be done with comparative safety in the middle of August, as the plants would not be through the ground in time to suffer damage. Broadly speaking, planting may take place with safety from two to three weeks prior to the probable date of the last spring frosts. Thus growers must be guided as to the date of planting by the spring frost records of their districts. Crops may be protected from frosts by means of smudge fires, but it is more practicable and less expensive to seek safety in later planting.

The first essential is that the land should have been thoroughly graded in order to facilitate the even distribution of the water. If dry, the land to be planted should be irrigated first. As soon as it can be worked both ways, with either the spring tooth or disc cultivator, immediately afterwards it should be harrowed. Ploughing and planting should then be commenced.

The quickest and most convenient plough to use is the three-furrow mouldboard, followed by manure sower and planters (hand labour). It is possible to obtain an attachment which may be fitted to the three-furrow plough, and by means of which the manure is dropped mechanically, and the driver sows the sets himself by dropping them through a funnel into the row in front of one of the furrows, where they are covered immediately. Because of its cost, however, such a machine would be justified only where a comparatively large area was being planted.

Failing possession of a three-furrow plough, a double-furrow and a single may be used together, or planting may be done with the single-furrow alone. Whichever plough is used, the furrows should be set to cut a width of 9 inches, and planting should take place in every third furrow, *i.e.*, the rows should be about 27 inches apart. The sets should be planted at a depth of not less than 5 inches, and from 14 to 15 inches between the plants in the row.

Care should be taken to harrow each day's planting on the day of planting; in fact, it cannot be harrowed too soon after planting takes place. The object of this is, of course, to conserve moisture.

Early varieties only are recommended, as, on account of their shorter period of maturation as compared with late sorts, the margin for error in their cultivation is lessened, with beneficial results to the grower. The weight of seed per acre recommended is not less than 12 cwt., and up to 16 cwt. per acre can be sown with advantage. The best class of seed is that which has been selected immature, and which is sprouted. This phase of potato culture has been exhaustively dealt with in previous articles.

(*To be Continued.*)

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Chemical Problems in Crop Production

BY

Sir Edward John Russell, O.B.E., D.Sc., F.R.S.

The classic chemical problems in crop production centre round the feeding of plants. It was in 1840 that Liebig by chemical reasoning and Lawes by empirical trials applied in practice the knowledge gained by plant physiologists about the nutrition of plants. Up to that time many agriculturists, knowing nothing about the scientific evidence to the contrary, had assumed that plants feed on the organic matter in soil. Liebig in his vigorous writings showed them that this was not so; he pieced together the scientific knowledge and gave a convincing picture of the plant deriving most of its food from the air in the form of carbon dioxide and oxygen, and the remainder from the soil, water and simple compounds of nitrogen, phosphorus, sulphur, potassium, calcium, magnesium, iron and other elements. These are then built up into the complex carbohydrates, proteins and other substances which finally form the plant tissues. Liebig argued that the soil resources could be increased by the addition of the appropriate chemical compounds, and Lawes showed how to do it; he set up experimental fields at Rothamsted and a factory in London, thus starting the artificial fertiliser industry which has now grown to such enormous dimensions that some 35 to 40 million tons are made annually in the different countries of the world. There are many technical problems connected with the industry that could profitably be discussed, but I shall confine myself to those relating to the agricultural side. For many years these were mainly concerned with showing how to fit the fertilisers into everyday farm use. The results were very striking.

Crop increases of 30 or 50% were not uncommon: the cereal crops were greatly increased by nitrogenous manures, and the very important root crops by superphosphate; the Rothamsted field plots started in 1843 afforded such striking demonstrations as farmers had never

before seen. In the words of Gilbert, the distinguished collaborator of Lawes, the unmanured crops growing alongside of their neighbours might almost be fancied to say : "If you won't feed me I won't grow." Those were spacious days for the farmer; prices were high and costs low; there was no need for stinginess in applying fertilisers. They were put on the ground in adequate amounts and a good response fully repaid the cost.

As years went by, costs began to rise and prices to fall; the margin of profit became exceedingly narrow and finally disappeared. New and more economical methods were required and the chemist was called in to find how little of the various fertilisers needed to be added to soils to serve for a particular crop. The first hypothesis had been that plants took from the soil those things they needed, and if, therefore, one wished to discover the fertiliser requirements of plants it was only necessary to find out what quantities of fertiliser constituents the plant contained. Average crops were therefore analysed so as to discover the amounts of phosphorus, potassium, nitrogen, etc., present; the soils were also analysed to find the amounts per acre of these elements present in suitable form for plant nutrition, and a simple subtraction sum showed how much, if any, artificial fertiliser need be supplied. The method was much used some 30 or 40 years ago; it was highly developed in the United States by Cyril Hopkins, who spoke of drawing up the "invoice of the Soil":

Phosphate in crop	..	..	..	30 lb. per acre.
„ „ soil	..	..	..	600 „ „ „
Average of good soils in district	..			2000 „ „ „

There seems sufficient phosphate for a number of crops, but, as the amount is far below the average content, there will certainly be need for phosphatic fertiliser if the average soils are known to respond—which in the region in question they were. This procedure was simple; it had, however, the weakness that it was not adequate—for two reasons: (1) one cannot say exactly how much available plant food there is in the soil; and (2) the plant is not a fixed definite entity, it has considerable range of variation.

It might seem relatively easy to determine how much phosphate or potash a given soil contains, but actually the total values given by ultimate analysis have had only limited utility. Hopkins was able to get something out of them, as also was Prescott in Australia, but in normal English experience they are not helpful. Better results have been obtained by adopting some analytical method that distinguishes between the more and the less soluble constituents—a distinction first emphasised by Daubeny in 1845 and reduced to laboratory terms by Dyer in 1894; indeed Dyer's method still remains the most useful we have.

The amounts of nutrient and other materials in the plant, however, are not determined by the needs of the plant but by the quantities available. The plant roots act like a partially permeable membrane; they absorb some of everything that is soluble in the soil; not, however, in the proportion in which it exists in the soil, but in a proportion modified by certain characters of the plant. This is well illustrated by the following figures showing the mineral constituents of grasses and clovers growing intermingled on the Rothamsted grass plots :

Variation in Composition of Mineral matter in plants growing side by side (Rothamsted Park Grass).

						Per cent in pure ash	
						Grass	Legumes
CaO	..	..	..	..	..	7.6—11.8	21.4—30.3
MgO	..	..	..	..	..	2.4— 3.7	3.6— 7.5
K ₂ O	..	..	..	..	..	22.6—37.9	11.2—31.3
Na ₂ O	..	..	..	..	..	0.4— 5.3	0.6— 9.6
P ₂ O ₅	..	..	..	..	..	5.7— 9.7	5.1— 8.6
SiO ₂	..	..	..	..	..	17.3—36.6	1.3— 1.9

Some of these absorbed substances greatly stimulate the production of carbohydrates and proteins in the plant: others do not. The final composition of the plant is, therefore, profoundly affected by the compositions of the soil, and, except in cases of extreme deficiencies, is not a good index of the fertiliser requirements of the plant.

A different approach has, therefore, become necessary. It is recognised that the subject is much more complex than had been supposed and it has had to be put on a much broader basis. The purpose of modern work is to discover the factors that govern the growth and composition of plants, and, having done that, to find the simplest and most economical method of bringing them under control. The study of soil fertility thus resolves itself into two parallel sets of investigations. Plant physiological work shows what the plant needs in order to attain its maximum growth; more precisely, how growth is affected by variations in the conditions, especially in the supplies of nutrients, water and air for the root, reaction of the medium, etc. Studies by soil investigators show how far a particular soil is likely to satisfy the conditions for full plant growth, and how it can be made to do so better than it naturally would. Soil fertility is dependent on five main factors: namely, adequate plant food supplies; adequate water supply; adequate space for the root system; air supply to the roots; and absence of injurious

substances. In practice, these are closely linked. A food supply adequate for one level of water supply is quite inadequate for another. F. G. Gregory and F. Crowther made some good experiments in the Sudan showing that, as the amount of irrigation water increased, the response to added nitrogen fertiliser also increased. It is, therefore, impossible to speak of the adequacy of the soil supplies of plant food except in terms of water supply. The same holds true of the other conditions of growth, particularly of air supply, which is largely a matter of soil texture.

The relation between the quantity of nitrate in the soil and the quantity of nitrogen present in the plant is fairly simple. The total quantity of nitrogen in the crop is roughly proportional to the supply, but the way in which the nitrogen is used varies according to the amount present and the water supply. The added nitrogen can lead to corresponding increase in crop without particular change in nitrogen content, or, if for any reason it fails to increase the yield, it can cause an increase in nitrogen content that may become very marked.

Extreme cases being omitted, the variations in composition due to increases in nitrogen supply are much less than the increases in yield. The first increments of nitrogen give considerable increments of crop: later ones give less. So the percentage of nitrogen in the crop, and especially in the grain, is first unchanged or even falls as the nitrogen supply increases, but with later increments of nitrogen it rises steeply. Over a fairly wide range, the nitrogen content is more affected by the water supply than by the nitrogen supply. This is what happens in normal fertility conditions: it holds not only for nitrogen but for the other elements that increase plant growth. The fertiliser causes the plant to grow more but does not much affect its composition or its quality.

Thus, sulphate of ammonia, in conjunction with superphosphate and potassic fertilisers, usually increases the potato crop by some 15 to 20 cwt. per acre for each cwt. that is given up to 2, 3, or sometimes 4 cwt. per acre. The change in composition is only slight, as also is the change in marks assigned by an expert chef for quality. On the other hand, the effect of soil differences is very great, as shown by a comparison of the Rothamsted with the Woburn results:—

Marks for Quality of Steamed Potatoes (1929).

Cwt. K_2O per acre	Woburn (Light soil)	Rothamsted (Heavy soil)	Cwt. N per acre	Woburn (Light soil)	Rothamsted (Heavy soil)
0	32.6	28.5	0	34.4	29.2
0.5	33.6	29.5	0.3	33.3	29.3
1.0	34.5	29.6	0.6	32.9	29.1

Percentage of Dry Matter in Tubers grown with Different Potassic Fertilisers.

K ₂ O per acre		No. of potassic fertilisers	Sulphate of potash	Muriate of potash	30 % potash Rate of dressing salt
1.0	Woburn, 1929	27.5	26.7	26.2	24.8
1.0	Rothamsted, 1929	26.1	25.9	24.9	24.2
0.8	" " 1930	23.1	23.3	22.7	22.1
0.8	" " 1931	20.9	20.5	20.2	20.2
0.8	" " 1932	22.6	22.1	..	..

Remarkable results are obtained when one gets away from the normal fertility range to the extremes of deficiency or excess. The form of the plant changes, in extreme cases, considerably; this is well shown in the Rothamsted experiments with mangolds. A large excess of nitrogen and a prolonged deficiency of potassium bring about striking changes in the plant and affect its reaction to insect and fungus attack. Wallace at Long Ashton has shown that nitrogen starvation of apple trees heightens the colour of the fruit.

Although it is not possible to lay down precise fertiliser recipes, crops do show certain general requirements. Practically all crops respond to nitrogenous fertilisers. Root and potato crops frequently respond also to superphosphate, and grass land to basic slag; leguminous crops, mangolds, potatoes and fruit commonly, to potassic fertilisers also. Wallace has shown that potassic and nitrogenous fertilisers are, as a rule, the most important fertiliser elements for fruit, phosphate being advantageous only for cover crops and for straw berries. In the west country at least, the potassium supply is the key to the successful nutrition of fruit trees, and by extending the use of potassic fertilisers, it has been possible to extend fruit growing and improving greatly the yields and quality in existing plantations. Trees suffering from shortage of potassium show a curiously high phosphorus content.

Differences in composition of the crop may have far-reaching consequences. Varieties of wheat have been bred at Svalof for resistance to winter frost; successful ones are found (Bengt Lidfores; Akerman) to contain a higher percentage of sugar in the leaf than the others. It is not supposed that the sugar confers frost resistance; the evidence is rather that the freezing of water in the intracellular spaces of the leaf causes water to pass out from the cell, making the cell sap more and more concentrated till finally the protein is irreversibly precipitated, apparently by a salting-out process, and the cell then dies. Maximov has shown, however, that the presence of sugar in the sap protects the protein against precipitation.

There are also some unexpected results. The same sugar that is associated with frost resistance also makes the leaves attractive to hares, so that winter resistant varieties tend to be eaten more than others.

The composition of the crop naturally affects its value as food, especially as animal food; this is particularly so for grass, which forms a large part, sometimes indeed the whole, of the food of the animals. In its early stage, grass is richer in protein and in mineral matter than at any later period; it, therefore, has high feeding value and efforts are now being made to preserve dried young grass for winter feeding. Among its other valuable constituents is carotene, the precursor of vitamin A, and the cause of the rich yellow colour in cream. Experiments at Jeallot's Hill have shown that yellow cream can be obtained in winter if the animal is given some of this dried grass.

In southern hemisphere, notably Australia and South Africa, and occasionally in England and Scotland, pronounced deficiencies of calcium, phosphorus, or other elements sometimes occur in soil, causing equally pronounced deficiencies in composition of vegetation, and these lead to marked nutritional troubles with the animals. These were first studied by Arnold Theiler and his colleagues in South Africa and the subject is being developed at the Rowett Institute, Aberdeen. Typical analyses of herbage associated with healthy and with diseased conditions of the animals are as follows:—

Percentage of Mineral Constituents in Dry Matter of Herbage.

	Scottish hill pastures		Kenya		New South Wales	
	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased
CaO ..	0.65	0.21	1.00	0.49	0.465	0.168
P ₂ O ₅ ..	0.67	0.29	0.93	0.19	0.184	0.047
K ₂ O ..	2.66	1.51	2.25	0.83	0.143	0.087
Na ₂ O ..	0.37	0.12	0.07	0.02	..	..
Cl ..	0.64	0.52	0.42	0.18	..	..
N ..	2.50	2.05	..	..	..	..
Total ash ..	7.18	5.33	..	..	..	..
Silica-free ash ..	5.85	2.82	..	..	..	..

The remedy consists in supplying the missing elements as "licks" or in fertilisers.

Where the diet includes a number of foods (as the ordinary human diet), differences in composition of individual foods tend to even out, so that for practical purposes the composition of individual items has usually little dietetic significance.

The factor of competition comes into play and introduces complications when several plants are growing together, such as the mixture of leguminous and non-leguminous plants grown for silage or fodder purposes or occurring naturally in grass land. Leguminous plants derive their nitrogen from the bacteria living in the nodules on their root; these fix nitrogen from the air and make the plants independent of nitrogenous fertiliser. The non-leguminous plants, however, are much favoured by nitrogenous fertiliser and grow so vigorously that they tend to crowd out the leguminous vegetation. Thus, it may happen that additions of nitrogenous fertiliser cause no increase in the amount of protein produced per acre. Phosphates, on the other hand, favour the leguminous plants, so that these increase when phosphatic fertiliser is supplied. This accounts for the remarkable improvements effected by basic slag on pasture land.

In regard to these principal elements of plant nutrition, it is now recognised that more and better field experiments are needed to provide the main facts on which the agricultural chemist can then proceed to work. The methods of field experiments have recently been completely overhauled; the experiments, of course, can never be exact, but they are now done in such a way that each experiment gives a measure of its own error. Simultaneously, chemical examination of the soils is made.

In recent years, it has been found that certain elements other than the classical ones are needed in very small amounts. Larger quantities become harmful, but the proper small quantity is indispensable.

Boron has been much studied at Rothamsted. Miss Warington found that it is essential for the proper development of broad beans, and later workers have shown that other plants need it also. Sugar beet affords an interesting example; in absence of the necessary trace of boron, a certain disease appears, which has caused some trouble in Central Europe and in the Irish Free State.

Manganese has been studied by Samuel and Piper at the Maite Institute, Adelaide. A trace of manganese sulphate (1 part per million) was found to be essential to the growth of plants. In its absence oats become liable to the grey fleck disease.

Allison in Florida has shown that minute traces of copper are essential to plant growth: he has obtained dramatic increases of yield on the Everglade soils by additions of traces of copper sulphate. We have, however, not yet found soils in this country that respond to copper salts. Zinc appears to be essential, at any rate for fruit trees; in its absence the curious rosette diseases set in.

Lithium salts are stated by Sir Rowland Biffen to confer resistance to mildew and yellow rust on wheat grown in pots,

Molybdenum salts injected into plants have been found by Miss Sheffield to induce a trailing habit of growth and also to produce symptoms apparently identical with those of virus disease in *Solanum nudiflorum*. W. A. Roach shows that the roots of fruit trees vary in their power of assimilating molybdenum from the soil: some can do it and others cannot.

Some of these curious stimulating substances are organic. They were first called auximones of growth promoters; now they are called auxins or growth enzymes. Owing to the difficulty of working with them, it has not always been possible to distinguish their effects from those of the inorganic promoters, and some of the auximone effects of the older workers are probably attributable to iron. But there are cases where the active agent is an organic substance, though, owing to difficulties of working, it is not possible to be quite sure. F. W. Went and Kozl have recently isolated, from the growing point of plants, an auxin which increases the growth of the upper parts by stimulating the elongation of the cell, and restricts the growth of the roots; they have gone so far as to ascribe the formula $C_{18}H_{32}O_5$ to one form of the auxin, and $C_{18}H_{30}O_4$ to another.

A remarkable substance has recently been isolated by H. G. Thornton at Rothamsted. The invasion of the root hairs of leguminous plants by the nitrogen-fixing bacteria is preceded by an excretion from the roots, which causes the bacteria in the soil to multiply. In turn, the bacteria excrete something which causes the root hairs to multiply and to curl; on the inner bend of the curl, the bacteria enter. This substance has been isolated and is being studied.

The late S. U. Pickering obtained evidence of plant excretions capable of injuring other plants: these results have never yet been satisfactorily explained. There is much empirical knowledge about the harmful effect of growing plants on soil: fruit stocks, for instance, cannot be raised in succession on the same land, but new land is needed for each crop. Whether this is the result of excretions or of exhaustion of some essential minor element is not known.

The growing plant also affects the soil in other ways. Wallace has shown that grass grown as a cover crop raises the potassium and the iron content of the soil water and may thus cure iron and potassium deficiencies on certain soils; it also lowers the N/K ratio. He thus explains the paradoxical result that clean culture of fruit is not always the best: weeds in the orchard have their uses.

The production of cellulose in the plant is now being studied at Rothamsted, by A. G. Norman, and is opening up considerable possibilities in view of its importance in industry.

The ripened seed has its own group of problems. Barley has been studied most completely and L. J. Bishop has found surprising regulari-

ties in the make-up of the grain under various conditions of growth. The nitrogen content may vary from 1.2 to 2.4 per cent. and the proteins and carbohydrates change correspondingly, but always in accordance with a definite pattern which remains constant for any given variety. The value of barley for brewing depends to a considerable extent on the quantity of nitrogen compounds present, large amounts being detrimental, especially for beers that have to be kept for some time before consumption. The value of wheat for baking, on the other hand, is usually enhanced by high protein content, but it is also much affected by the physical state of the protein.

Many of the chemical problems in agriculture are shifting over to the direction of physical chemistry and especially to the branch that deals with colloids.

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